



ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF MECHANICAL ENGINEERING



CME388 INDUSTRIAL SAFETY

(Lecture Notes)

Regulation-2021

UNIT – I	INDUSTRIAL SAFETY	9
<p>Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.</p>		
UNIT – II	MAINTENANCE ENGINEERING	9
<p>Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.</p>		
UNIT – III	WEAR AND CORROSION AND THEIR PREVENTION	9
<p>Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.</p>		
UNIT – IV	FAULT TRACING	9
<p>Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.</p>		
UNIT – V	PERIODIC AND PREVENTIVE MAINTENANCE	9
<p>Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of:i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.</p>		

TOTAL: 45 PERIODS

TEXT BOOKS:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.

REFERENCES:

1. Edward Ghali, V. S. Sastri, M. Elboujdaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007
2. Garg, HP, Maintenance Engineering, S. Chand Publishing.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017
4. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5. W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014

Unit 1 INDUSTRIAL SAFETY

ACCIDENT

INTRODUCTION:

Thousands of workers die every year because of unsafe working conditions, and even more deaths occur every year due to work-related illnesses like cancer. In addition, industrial accidents cause countless injuries with varying degrees of severity. Nobody ever plans or schedules accidents, but most people can help prevent accidents by using common sense and caution.

Industrial accidents like petrochemical plant accidents can obviously harm workers at the job sites, but they can also cause great damage to the surrounding area and the environment as well. When chemical plant accidents cause harmful substances to pollute the air, people even miles away from the site may suffer from the consequences. Infrastructure failures, dangerous procedures and certain human actions have the potential to cause technological hazards in industrial environments, which can even lead to wrongful death in industrial accidents.

ACCIDENT

Industrial accident is any accident that occurs in the course of work resulting to injury. Industrial accident is often avoidable but require awareness of proper safety protocols by both the employee and management.

Classification of Accident:

Industrial accidents generally classified as follows:

1. Environmental Causes of Accidents

Accidents which occur from environmental causes refer to those workplace accidents that happen because of the working environment. The environmental factors can be both natural and man-made such as workplace design. Common environmental causes of accidents include:

- Poor lighting – Low visibility is a common cause of slips, trips, and falls.
- Ambient temperature – If a workplace is too hot, overheating can occur. If the workplace is too cold, frostbite or hypothermia can occur.
- Air pollution – Breathing issues can develop if a workplace has poor ventilation and/or air pollution.
- Sound pollution – The sound in a workplace can cause injury to a worker's hearing.

2. Mechanical Causes of Accidents

Mechanical causes of industrial accidents are factors that refer to machine or equipment failure or breakdown. Generally, with proper maintenance and safety processes in place, these types of accidents are preventable. Common mechanical causes of accidents include:

- **Broken or damaged machine** – Parts can be easily broken or damaged if made of poor-quality metal.
- **Power failure** – Total or partial power failure can lead to serious injury.
- **Fire or explosion** – Cooling failure or a small spark can lead to a mechanical fire or explosion.
- **Fair wear and tear** – The older machine, the more wear and tear on the parts which can lead to a higher risk of mechanical accident.

3. Human Factors That Cause Industrial Accident

Accidents caused by human factors refers to incidents in which the accident is directly attributed to the worker involved in the accident. Common human factors that cause **industrial accidents include:**

- **Poor housekeeping** – An unkempt work space can lead to slips, trips, and falls.

- **Fatigue** – When a body is tired, injury is more likely to occur.
- **Overexertion** – Overexertion injuries are the most common type of workplace injury.
- **Stress** – Workers who are stressed are often more distracted and of greater risk of injury.
- **Dehydration** – It is important to consume enough water to ensure your body functions properly.
- **Improper Lifting** – Lower back strains and shoulder injuries are common among workers who use improper lifting techniques.

Some other major causes:

Taking shortcuts: Everyone wants to work faster. Unfortunately, when workers take shortcuts on the job – especially when lethal chemicals or machinery is involved – they are putting themselves and fellow employees at risk of an accident.

Poor management of space: According to Safety Partners LTD, “A poorly kept up [work] area leads to hazards and threats everywhere. Not only does good housekeeping lead to heightened safety, it also sets a good standard for everyone else in the workplace to follow.”

Neglecting safety procedures: Agencies like Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) have specific safety guidelines that employers must follow. Failing to comply with OSHA or NIOSH standards will not only result in serious penalties, but can also result in serious injury or death.

Most industrial accidents are based on negligence, which means most of them are also largely preventable. By ensuring a safe work environment, adequate training and supervision, and proper maintenance of equipment, the risk of serious injury and death in an industrial accident drops dramatically. If you or a loved one has been injured in an industrial accident, contact an experienced Texas work injury lawyer today.

How Do Industrial Accidents Occur?

Industrial disasters can occur because of accidents, incompetence or negligence and may cause property damage, injury or loss of life. In addition, those hazards may degrade the environment and disrupt society and the economy. Industrial accidents, also known as technological disasters, are non-natural calamities and include a variety of occurrences.

Types of Industrial Accidents

The following types of accidents fall under the category of industrial accidents:

Accidental Release – Hazardous chemical substances accidentally released during their production, handling or transportation endanger anyone near the release site.

Acid Rain – Chemical pollutants like nitrogen compounds and sulfur can cause ecological and agricultural damage by raising the level of acidity in the soil and water. When the atmosphere holds an acute concentration of acidic compounds, a washout results in acid rain, which deposits the compounds in the soil and water.

Atmospheric Pollution – Nuclear explosions, chemicals, burning artificial or natural fuels and other industrial practices can produce large amounts of radiation, solids and gases that contaminate the atmosphere and endanger those who live or work in the area.

Chemical Explosion: The forceful explosion of combustible materials usually involves chemicals and typically causes injuries, loss of life and great destruction of property.

Chemical Pollution – Permanent skin damage and internal bodily disorders can occur after chemicals suddenly pollute the air or water at or near industrial areas.

Explosion – A disaster classified as an explosion occurs if the explosion is actually the disaster. An event classified as a resulting disaster occurs if an explosion causes another disaster.

Mine Explosion – Coal dust or natural gas can react with the air and cause accidental explosions.

Nuclear Explosion or Radiation – International laws establish the levels of radiation allowable in civil facilities to maintain safety, and the accidental release of radiation can cause higher levels that exceed the safety standards.

Pollution – Synthetic products or other debris as well as mishandling environmental or natural resources can create noxious biological, chemical or industrial wastes that degrade one or more environmental aspects.

A petrochemical plant accident or a chemical plant accident can be particularly disastrous because exposure to dangerous chemicals may cause injuries that are not immediately apparent. Delaying diagnosis and treatment of injuries may make them harder to treat and increase their severity. People exposed to chemicals or radiation may require prolonged treatment for their physical injuries as well as psychological support to help them deal with the emotional trauma they may experience because of an accident.

Causes of Industrial Accidents

Most industrial accidents are caused by unsafe conditions, which is another way of saying, they should have never happened in the first place. The most common causes of industrial accidents include:

- Improper training and supervision;
- Careless operation;
- Inadequate personal safety gear;
- Defective or malfunctioning equipment;
- Unsafe storage;
- Poor house-keeping;
- Improper ventilation;
- Dangerous working conditions, such as slippery floors and excessive heat;
- Poor maintenance of equipment;
- Poorly-guarded equipment; and
- Insufficient lighting.

The above scenarios are frequently linked to industrial accidents and disasters. Workers who abuse drugs or alcohol, or who are fatigued due to being overworked or working the night shift, also contribute to these accidents.

Prevention Of Industrial Accidents

When it comes to industrial accidents, incidents are almost always preventable when proper safety measures and employee training are in place. Tips for avoiding industrial accidents include:

1. Obey Safety Requirements

One of the main causes of injuries and accidents on the job is failure to comply with safety regulations.

If you are an employer, then be sure to provide proper safety training for your employees and post warnings and instructions throughout the workspace to ensure that your employees know what they should and shouldn't be doing. If you are an employee, make sure you know what the rules are and that you follow them – because even when a safety precaution seems ridiculous, it's in place because it has prevented injury (or death) in the past.

2. **Communicate**

Another way to help prevent accidents on the job is to be in constant communication with other workers in your area. If you are working with heavy machinery, make sure everyone knows what you're planning to do. If you need to walk through a hard hat zone, make sure you talk to someone and know what work is being done in the area so that you are on the alert.

3. **Provide/Get Proper Training**

As an employer, make sure your workers know what they are doing. Provide proper training to anyone who is going to use heavy machinery, chemicals, or dangerous products of any kind. As an employee, make sure you know how to properly use a machine, a chemical, or any other dangerous product – never assume you can figure it out yourself.

4. **Keep Machinery & Equipment in Working Order**

When was the last time your machine got a tune-up? Does it have any parts that need replacing? Is there damage that you don't know about? Always make sure you are using a machine that has been recently inspected and has received proper maintenance and repairs before you take it out on the job.

5. **Don't Take Shortcuts**

Faster isn't always better, especially when safety can be jeopardized. Do your work the right way and always make sure to keep safety your number one priority, even if it takes a little longer. You could save a life – possibly even yours.

Other tips include:

- Developing an employee safety plan with feedback from all level employees
- Requiring monthly employee training and promote safety awareness with an internal safety committee
- Focusing on skill development and education of all employees
- Ensuring supervisors are monitoring and reporting on the progress of all safety measures
- Providing avenue for employees to share safety concerns and ideas for improving safety
- Establishing a planned maintenance schedule for all machines – daily, weekly, monthly based on manufacturer suggestion
- Quickly repairing and addressing all defective or broken machine parts
- Testing all equipment before use
- Creating a regular inspection schedule and put mechanisms in place to ensure it is adhered

Objectives of Factories Act, 1948

Heath: According to the Act, all factories must be kept clean, and all essential safeguards must be taken to safeguard the health of workers. The factory must have a sufficient drainage system, adequate lighting, ventilation, temperature, etc. There must be clean water supplies.

Colour code of Safety

Red: Fire protection equipment, Danger, High risk of Injury or Death.

Orange: Moderate risk of injury, Guarding Devices.

Yellow: Caution statement, Minor risk of injury.

Green: Safety equipment or Information.

Blue: No immediate hazard

White: Poison or Toxic.

FIRE PREVENTION AND FIREFIGHTING

Fire Triangle: -

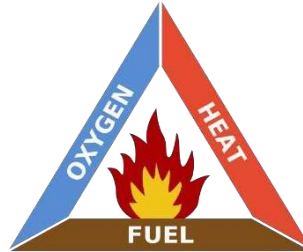


Figure 1. - Fire triangle

The starting of a fire involves three elements - fuel, oxygen, and ignition temperatures. These elements may be compared to the three legs of a triangle (fig. 1), for fire cannot occur until all three are brought together.

The following is a common cause of fires in terms of the fire triangle. A cigarette is carelessly discarded and comes to rest on a scrap of paper. The heat of the glowing cigarette is sufficient to cause the fuel - in this case, the paper (with a low ignition temperature)- to give off vapor.

Oxygen is present, and when the vapors are given off in sufficient quantity the mixture ignites, the cigarette being hot enough to supply the ignition temperature. Because of the relatively large surface area, the fire spreads rapidly and grows in intensity, building up higher temperatures, causing more and more vapors to be given off.

The heat of the flame causes the hot air to rise, drawing in additional oxygen to combine with the vapors and feed the flames. Referring to the fire triangle, to extinguish a fire, it is necessary to break up the triangle by taking away any one of its sides.

This may be accomplished in various ways, as will be pointed out in the following sections.

Classification of Fires.

Definition and Types.-

Classification of fires is the systematic arrangement in classes of the various substances that as fuels produce heat by combustion, as follows:

Class A:

Ordinary combustible materials such as wood, cloth, paper, and some rubber and plastic materials.

Class B:

Flammable liquids, gases, greases, and some rubber and plastic materials. Flammable or inflammable

(identical in meaning) liquids do not themselves burn or explode, but, as pointed out previously, the gases or vapors formed when they are heated and evaporated explode; that is, the change of state from liquid to gas must first occur.

As long as they are in a liquid state with no vapors being given off, there is little or no hazard. For the more volatile liquids, such as gasoline, storage in a closed container is a necessity. In order for any vapor to explode, it must have the correct vapor-air ratio, just as in the carburetor of a car. When the engine is flooded with gas, the mixture is too rich and fails to ignite. The same holds true in gasoline storage.

The danger is when the gases being poured from one container to another, thus giving the vapors the change to mix with the correct amount of air to form an explosive mixture. The same circumstances hold true with all flammable oils when enough heat is present to release vapors from the liquid.

Keeping in mind that a flammable liquid is not hazardous as long as it is not hot enough to give off vapors which can mix with the oxygen in air and burn, two things can be done:

- (a) The liquid can be cooled down to the point where no vapors are given off; and
- (b) the supply of oxygen can be blanketed out.

Some flammable liquids give off vapors at temperatures ordinarily considered cold. For

example, gasoline vaporizes at -43 EC (-45 EF) or lower. 2.1.3.

Class C:

Live electrical equipment. When equipment is de-energized, extinguishers for class A or B fires could be used safely;

however, in fighting an electrical fire there are two important things to be taken into consideration: namely

- (a) damage to the equipment far beyond what the fire could do, and
- (b) danger to the individuals fighting the fire.

To avoid these two possibilities, de-energize the circuit and use only the types of extinguishment recommended for class C fires.

Class D:

Combustible metals such as magnesium, titanium, sodium, potassium, lithium, and zirconium.

PORTABLE FIRE EXTINGUISHERS

Types and Usage:

All extinguishers of a portable type act as a "first-aid" appliance for extinguishing fires in their incipient stage, and they cannot be expected to be effective after a fire has spread to involve a large amount of combustible material.

The action of all extinguishers is by cooling the burning substance below its ignition temperature and by excluding the air supply (blanketing out the oxygen), or by a combination of these methods. Also, some types tend to inhibit oxidation by chemical action.

FIRE PREVENTION:

A fire can occur at any time. Therefore, various measures are to be adopted in advance to prevent a fire in your building. Some of the measures need to be adopted are given below:

- Prohibit smoking in storage areas of flammable materials.
- If electrical equipment is not working properly or if it gives off an unusual odour disconnect the equipment and call the duty electrician.
- Properly replace any electrical cord that is cracked or has broken connection.
- When using extension cords, protect them from damage. Do not put them across doorways or any place where they will be stepped on or chafed. Check the amperage load specified by the manufacturer.
- Do not plug an extension cord into another, and do not plug more than one extension cord into one outlet.
- Keeps all heat producing appliances away from the wall and away from anything that might burn and spread fire. Leave plenty of space for air to circulate around equipment that normally gives off heat.
- Make sure all appliances in your area such as hot plates, ovens, toasters, mixers, grinders, geezers, clothing irons are turned off when not in use.
- Use ash trays and empty them only when you are sure the ashes, matches and butts are cold.
- Make sure that no one including visitors has left cigarettes smoldering in waste – baskets or on furniture's, sofas, beds, etc.
- Keep storage areas, stairway landings and other out of way locations free of waste paper, empty cartons, dirty rags and other material that could fuel a fire.
- Report all fire hazards to the institute security & fire safety wing.
- Create awareness to use fire retardant furniture's, carpets, curtains, etc.
- Follow good housekeeping practices – because a clean house is a safe house

EQUIPMENT AND METHODS

Fire Extinguisher Operation Remove the fire extinguisher from its supporting bracket carefully; extinguishers are surprisingly heavy. The lower handle on the valve will support the extinguisher when carried.

- Remove the pin from the handle by pulling the ring, breaking the plastic tamper-evident seal.
- Aim the nozzle at the base of the flames, squeeze the handles together, and sweep the nozzle slowly from side to side, across the width of the flames until the fire is extinguished or the extinguisher is empty. You may repeatedly start and stop the flow of the extinguisher by squeezing and releasing the top handle.
- If a fire is not successfully controlled with one extinguisher, you should leave immediately. Inform to the Campus security and Safety wing, even if you successfully extinguish the fire. Compatibility of Extinguishers and Fires Dry chemical Powder (DCP) extinguishers are safe and effective against all ordinary types of fires).

- Pressurized water extinguishers are effective only against ordinary combustibles, such as paper, wood, fabric, trash, etc.

They must never be used on flammable liquid/oil fires or fires involving live electrical circuits.

Carbon dioxide extinguishers shaped black nozzle, no pressure gauge work only against flammable liquid fires and are safe to use around live electrical circuits.

They will not extinguish fires involving ordinary combustibles and must be discharged within about 3 feet of flames to be effective