



Supervisors Training Centre, South Central Railway



ISM-02

Industrial Safety, first aid & firefighting (MRT-01)

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INDEX

SN	Topic	Page No.
1.	Causes of fire	1.1
2.	Identifying and Handling of Fire Extinguisher.....	2.1-2.4
3	Precautions to be taken while extinguishing fire.....	3.1-3.2
4.	First aid to burns and Suffocation.....	4.1-4.2
5.	Rules of First aid and Structure of body.....	5.1-5.3
6.	Circulation of Blood.....	6.1-6.3
7.	Shock and its Management.....	7.1-7.3
8.	Fractures.....	8.1
9.	Transport of injured persons.....	9.1
10.	Principles of Accidents, Causation and its prevention.....	10.1-10.4
11.	Housekeeping and material handling.....	11.1-11.10
12.	Safety on small tools and electrical appliances.....	12.1-12.4
13.	Factories Act 1948 & Employees compensation Act 1923.....	13.1-13.5
14.	Role of Supervisors on Safety, Accident Reporting and Investigation	14.1-14.4

1.0 Causes of Fire

Identification of Unsafe Conditions And Unsafe Acts

Main cause is a source of ignition coming in contact with combustible material in the presence of air

1.1 Common causes of industrial fires or identification of unsafe conditions and unsafe acts:

- Leaks and spillages of flammable /combustible materials.
- Electrical short circuiting and over loading.
- Overheated bare surfaces/heaters/electrical lamps
- Welding, cutting, soldering and other hot work.
- Equipment failure.
- Smoking in prohibited areas.
- Chemical reaction, runaway reaction.
- Frictional heat /spark.
- Spontaneous combustion.
- Static spark/ combustion sparks/lighting.
- Naked lights.
- Molten substances.

1.2 Basic Preventive Measures:

- Ensure high housekeeping standards.
- Cover trash containers tightly and empty regularly.
- Segregate flammable materials from the source of ignition.
- Promptly eliminate oil and gas leaks and clean spillages of flammable materials.
- All storage vessels and pipe lines carrying flammable materials should be grounded and bonded.
- Strictly adhere to work permit instructions for welding, cutting and other hot work in areas where flammables are present.
- Store incompatible chemicals separately.
- Where flammables are stored and used, ensure adequate ventilation, prohibit smoking, and use flame proof electrical equipment.
- Use fuses and circuit breakers of correct capacity.
- Keep fuses and control boxes clean and closed.
- Avoid multi socket connections.
- Electrical repairs should be carried out by qualified personnel.
- Do not use damaged chords and avoid temporary connections.
- Lubricate, maintain and align all machines/ equipment to prevent generation of heat.

2.0 Identifying and Handling Of Various Types of Fire Extinguishers

2.1 Types of Fires:

Class A: Fires involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers (e.g. paper, wood, textiles).

Class B: Fires involving liquids or liquefiable solids (e.g. petrol, oil, paint).

Class C: Fires involving gases (e.g. hydrogen, propane, butane).

Class D: Fires involving metals (e.g. potassium, magnesium, sodium).

Class E: Electrical fires.

Class F: Fires involving cooking oils and fats.

2.2 Suitability of Fire Extinguisher Type:

	A	B	C	D	E	F
Water	✓					
Foam	✓	✓				
Dry Powder	✓	✓	✓		✓	
Carbon Dioxide (CO ₂)		✓			✓	
Wet Chemical	✓					✓

2.3 Water Fire Extinguishers:

(a) Advantages:

Water fire extinguishers are good for tackling class A fires involving burning wood, paper, textiles and general combustible materials. They don't contain any harmful chemicals or residual agents and they are kind to the environment.

(b) Disadvantages:

The downside is that they are strictly for class A use only and can make the fire worse or cause harm to the user if used on other classes of fire. Water conducts electricity and thereby presents a risk of electrocution to the user if used on live electrical equipment.

(c) Extinguishing Method:

Water fire extinguisher work by cooling and quenching of a fire. They absorb heat from the fire and convert it into steam to reduce its temperature below the critical level needed to sustain the fire.

2.4 Foam Fire Extinguisher:

(a) Advantages:

Foam fire extinguishers are especially suitable for class B flammable liquid fires such as paints, thinners, petrol and oil spills. Foam is also very effective on class A fires such as man-made furnishings. They have a higher class A fire rating per litre than their water counterparts and can therefore be more lightweight and portable, making them a good choice for an office fire extinguisher.

(b) Disadvantages:

As they are wet they will damage dry goods such as office documents or stock that they come into contact with.

(c) Extinguishing Method:

Foam fire extinguishers work by covering a fire with a film of foam that starves it of oxygen and prevents re-ignition, in addition to penetrating absorbent materials and having cooling and quenching properties due to the water content.

2.5 Dry Powder Fire Extinguisher:

(a) Advantages:

Dry powder fire extinguishers are a multi-purpose and highly effective extinguishing agent, making them an excellent choice for use in many circumstances. They are ideal for use in warehouse and factory environments and other areas where the considerable advantages offered by their effectiveness and multi-purpose application outweigh the disadvantage of their residual properties. As their extinguishing medium is dry they will not cause damage to items such as documentation in the way that wet types such as water or foam will.

(b) Disadvantages:

The downside is that they leave a very fine powder residue that will disperse on discharge over a wide area and settle into every nook and cranny, making the clean-up process of small fires more problematical.

The powder residue can cause damage to sensitive electronic equipment such as circuit boards, computers and production machinery etc. The ammonium phosphate within the extinguishing agent can undergo hydrolysis to form phosphoric acid which is extremely corrosive to ferrous metal and alloys and may also attack some plastics, rubber and coatings. Every particle of this powder will potentially cause damage to such equipment and machinery and therefore every particle must be removed during the clean-up process. As this is impossible to achieve in practice, its use should be avoided in such environments.

Dry powder introduces exposure hazards in three ways:

- a. It causes irritation on contact with skin.
- b. It causes irritation and discomfort on contact with eyes.

- c. It causes breathing discomfort on inhalation.

For these reasons, the use of dry powder extinguishers should be avoided in environments where its discharged powder residue will come into contact with people.

They should not be used in offices or in contaminant-sensitive environments such as food preparation areas or laboratories etc.

Dry powder extinguisher must not be located along emergency fire escape routes.

(c) Extinguishing Method:

Dry powder fire extinguishers work by fusing particles of blended ammonium phosphate sulphate powder over a fire to form a barrier that starves it of oxygen and prevents re-ignition and acts to knockdown a fire.

2.6 Carbon Dioxide (CO₂) Fire extinguishers:

(a) Advantages:

Carbon Dioxide (CO₂) fire extinguishers are safe for use on electrical appliances and are non-residual, making them ideal for use in office environments where sensitive computer equipment would be damaged by using other types of extinguishing agents.

(b) Disadvantages:

As CO₂ does not cool the fire very well, there is a risk of the fire re-igniting. Fumes from CO₂ extinguishers can be harmful if used in confined spaces. The non-insulated horns freeze during discharge, so care must be taken not to touch it.

(c) Extinguishing Method:

CO₂ fire extinguisher work by displacing oxygen at the source of the fire with an inert gas, thereby starving the fire of the oxygen that is essential to the combustion process. They also have some cooling properties.

2.7 Wet Chemical Fire Extinguishers:

(a) Advantages:

Wet Chemical fire extinguishers are specially designed for class F fires in kitchens involving burning cooking oils and fats like deep fat fryers.

(b) Disadvantages:

No disadvantage for their intended application. However, it is essential that the intended user should be trained in the proper application of this specialised extinguisher.

(c) Extinguishing Method:

Wet chemical fire extinguishers work by covering burning oil in a cooling layer of foam means of a long lance applicator. Most class F extinguishers contain a solution of potassium acetate, sometimes with some potassium citrate bicarbonate

added. The extinguisher sprays the solution as a fine mist which cools the fire while the potassium salts saponify the surface of the burning oil, producing a layer of thick, soap foam over the surface that smothers it and prevents re-ignition. This saponification only works on animal fats and vegetable oils.

3.0 Precautions to be Taken While Extinguishing Fire

When used properly, a portable fire extinguisher can save lives and property by putting out a small fire or controlling it until the fire department arrives. Portable extinguishers, intended for the home, are not designed to fight large or spreading fires. However, even against small fires, they are useful only under certain conditions:

- The operator must know how to use the extinguisher. There is no time to read directions during an emergency.
- The extinguisher must be within easy reach and in working order, fully charged.
- Some models are unsuitable for use on grease or electrical fires.

3.1 Select Your Extinguisher:

Choose your extinguisher carefully. A fire extinguisher should bear the seal of an independent testing laboratory. It should also be labelled as to the type of fire it is intended to extinguish.

The extinguisher must be large enough to put out the fire. Most portable extinguishers discharge completely in as few as eight seconds.

3.2 Classes of fires:

There are three basic classes of fires. All fire extinguishers are labelled with standard symbols for the classes of fires they can put out. A red slash through any of the symbols tells you the extinguisher cannot be used on that class fire. A missing symbol tells you only that the extinguisher has not been tested for use on a given class of fire.

Class A: Ordinary combustibles such as wood, cloth, paper, rubber, and many plastics.

Class B: Flammable liquids such as gasoline, oil, grease, tar, oil-based paint, lacquer, and flammable gas.

Class C: Energized electrical equipment including wiring, fuse boxes, circuit breakers, machinery, and appliances.

Many household fire extinguishers are "multipurpose" A-B-C models, labelled for use on all three classes of fire. If you are ever faced with a Class A fire, and you don't have an extinguisher with an "A" symbol, don't hesitate to use one with the "B:C" symbols.

Warning: It is dangerous to use water or an extinguisher labelled only for Class A fires on a grease or electrical fire.

3.3 Extinguisher sizes:

Portable extinguishers are also rated for the size of fire they can handle. This rating is a number from 1 to 40 for Class A fires and 1 to 640 for Class B fires. The rating will appear on the label. The larger the number, the larger the fire extinguisher can put out. Higher-rated models are often heavier. Make sure you can

hold and operate the extinguishers are rated 1A or 2A and/or 5B, 10B, or 20B. The "C" just indicates that you can use it on electrical fires.

3.4 Installation and Maintenance:

Extinguishers should be installed in plain view above the reach of children near an escape route and away from stoves and heating appliances.

Extinguishers require routine care. Read your operator's manual and ask your dealer how your extinguisher should be inspected and serviced. Rechargeable models must be serviced after every use. Disposable fire extinguishers can be used only once; they must be replaced after one use. Following manufacturer's instructions, check the pressure in your extinguishers once a month.

3.5 Remember the Pass Word:

Stand 6 to 8 feet away from the fire and follow the four-step PASS procedure. If the fire does not begin to go out immediately, leave the area at once. Always be sure the fire department inspects the fire site.

PULL the pin out: This unlocks the operating lever and allows you to discharge the extinguisher. Some extinguishers have other devices that prevent inadvertent operation.

AIM LOW: Point the extinguisher nozzle (or hose) at the base of the fire.

SQUEEZE the lever below the handle: This discharges the extinguishing agent. Releasing the lever will stop the discharge. Some extinguishers have a button that you press.

SWEEP from side to side: Moving carefully toward the fire, keep the extinguisher aimed at the base of the fire and sweep back and forth until the flames appear to be out. Watch the fire area. If the fire re-ignites, repeat the process.

3.6 Before you begin to fight a fire:

- Make sure everyone has left, or is leaving, the building.
- Make sure the fire department has been notified by dialling 911.
- Make sure the fire is confined to a small area and that it is not spreading beyond the immediate area.
- Make sure you have an unobstructed escape route to which the fire will not spread.
- Make sure that you have read the instructions and that you know how to use the extinguisher.

It is dangerous to fight a fire under any other circumstances. Instead, leave immediately and close off the doors and windows if possible.

4.0 First Aid to Burns and Suffocation

4.1 Asphyxia (Suffocation):

When lungs are not getting sufficient fresh air, important organs of body mainly brain deprive of oxygen, it is a dangerous condition called Asphyxia.

4.1.1 Causes:

- Drowning
- Breathing polluted air
- Pressing of wind pipe (Hanging, Throttling and strangulation)
- Choking
- Pressure/weight on chest.
- Electric shock
- Some poisons.
- Obstruction in air passage.

4.1.2 Signs and Symptoms:

- Low/No Breathing
- Blue/Pale colour of cheeks and lips.
- Swelling of veins at neck.
- Unconsciousness.

4.1.3 Treatment for Asphyxia:

- Remove cause from casualty or casualty from cause.
- Ensure more fresh air (By opening doors and windows and removing the people surrounded); loosen the tight clothing at chest and neck regions.
- Start artificial Respiration without wasting even few seconds.
- Arrange medical aid.

Note:-

Normal Breathing (Respiration) Rate 15 – 18 times per minute.

Normal Heart Beat/pulse rate 72 times per minute.

4.2 Burns and Scalds:

Burns can be caused by fire, the sun, chemicals, heated objects or fluids, and electricity. They can be minor problems or life-threatening emergencies. Distinguishing a minor burn from a more serious burn involves determining the degree of damage to the tissues of the body. If you are not sure how serious the burn is, seek emergency medical help.

First-degree burns are those in which only the outer layer of skin is burned. The skin is usually red and some swelling and pain may occur. Unless the burn involves large portions of the body, it can be treated at home.

Second-degree burns are those in which the first layer of skin has been burned through and the second layer of skin is also burned. In these burns, the skin

reddens intensely and blisters develop. Severe pain and swelling also occur. If a second-degree burn is no larger than 2 or 3 inches in diameter, it can be treated at home. If the burn covers a larger area, seek medical attention.

Third-degree burns are the most serious and involve all layers of skin. Fat, nerves, muscles, and even bones may be affected. Areas may be charred black or appear a dry white. These burns should receive emergency medical attention.

4.2.1 Steps to be followed for minor burns at home:

1. If the skin is not broken, run cool water over the burn for several minutes.
2. Cover the burn with a sterile bandage or clean cloth.

4.2.2 Treatment:

1. Remove the person from the source of the burn (fire, electrical current, etc.).
2. If the person is not breathing, begin mouth-to-mouth resuscitation immediately
3. Remove all smouldering clothing to stop further burning.
4. If the person is breathing sufficiently, cover the burned area with a cool, moist, sterile bandage or clean cloth. Do not place any creams, ointments or ice on the burned area or break blisters. Look for medical help. Protect from nearby hazards.

Scald is an injury caused by Moist Heat such as Hot water, milk oil tar steam etc.

If a person's cloth catches fire, do not allow him to run pour plenty of water or gently place him on ground and roll him slowly to put off flames.

4.2.3 Degrees of burns:

Ist degree - Redness of skin and blister formation,

IInd degree - Internal tissue damage and scar formation,

IIIrd degree - Complete charring of part.

4.2.4 General treatment (F.A.Treatment):

Cool and clean the affected area with wet cloth/cotton or flood with water or dip into water if it is possible. Remove any constraint articles like bangles, rings, watches immediately otherwise they cannot be removed later. Remove the burnt cloths by cutting which are not stick to the skin.

Cover the area preferably with laundered towel and bandage but do not disturb blisters while bandage.

If he is conscious give water with pinch of salt to make good of lost salt and water, weak tea with more sugar also may be given if he is not diabetic patient.

5.0 Rules of First Aid and Structure of Body

The immediate treatment given to the victim of an accident or sudden illness before the arrival of the doctor is called First Aid.

5.1 Aim / Objectives:

- Save the life.
- Promote the recovery.
- Prevent the worsening of the condition.
- Arrange the transport.

5.2 Contents of the First Aid box:

Set of splints.	:	One Set
Roller Bandage	:	10
Triangular bandages	:	4
Tourniquet bandages	:	2
Cotton Wool	:	4
Safety Pins	:	10
Adhesive Dressing	:	20
Paracetamol Tab	:	20
Antiseptic Cream	:	1
Diazepam Tab	:	10
Injury Card	:	1

5.3 Utilisation of First Aid Box Items:

- a. Triangular Bandages:
 - To retain dressings and splints in position and to immobilize fractures.
 - To afford support to an injured part or in the form of slings.
 - To control bleeding.
 - To reduce or prevent swelling.
 - To assist in the lifting and carrying of casualties. Mainly used as bandages like Head bandage, chest bandage, shoulder bandage, elbow bandage, hand bandage, hip bandage, foot bandage etc. It is also used as slings like Arm sling, Triangular sling and cuff and collar sling.
- b. Tourniquet/Rubber Bandage: It is used to stop bleeding and to stop spreading of poison when snake bites.
- c. Roller Bandages: It is used to retain dressings and splints in position and to cover the wounds.
- d. Splints: They are used to immobilize and support the fractured limbs.
- e. Paracetamol Tab: These are used to relieve minor pains.
- f. Antiseptic Cream: It is used to minimize or prevent infection to wounds.
- g. Cotton wool: It is used to clean/pad the wounds. It is also to be utilised to absorb discharges when there is a wound.
- h. Adhesive Dressings: It is used for minor wounds only.

- i. Safety Pins: It is used when Triangular bandage used for victim.
- j. Injury Card: To maintain the account of the First Aid items.

5.4 Structure and Function of body:

Our bodies consist of a number of biological systems that carry out specific functions necessary for everyday living.

The job of the **circulatory system** is to move blood, nutrients, oxygen, carbon dioxide, and hormones, around the body. It consists of the heart, blood, blood vessels, arteries and veins.

The **digestive system** consists of a series of connected organs that together, allow the body to break down and absorb food, and remove waste. It includes the mouth, esophagus, stomach, small intestine, large intestine, rectum, and anus. The liver and pancreas also play a role in the digestive system because they produce digestive juices.

The **endocrine system** consists of eight major glands that secrete hormones into the blood. These hormones, in turn, travel to different tissues and regulate various bodily functions, such as metabolism, growth and sexual function.

The immune system is the body's defense against bacteria, viruses and other pathogens that may be harmful. It includes lymph nodes, the spleen, bone marrow, lymphocytes (including B-cells and T-cells), the thymus and leukocytes, which are white blood cells.

The **lymphatic system** includes lymph nodes, lymph ducts and lymph vessels, and also plays a role in the body's defenses. Its main job is to make and move lymph, a clear fluid that contains white blood cells, which help the body fight infection. The lymphatic system also removes excess lymph fluid from bodily tissues, and returns it to the blood.

The **nervous system** controls both voluntary action (like conscious movement) and involuntary actions (like breathing), and sends signals to different parts of the body. The central nervous system includes the brain and spinal cord. The peripheral nervous system consists of nerves that connect every other part of the body to the central nervous system.

The body's **muscular system** consists of about 650 muscles that aid in movement, blood flow and other bodily functions. There are three types of muscle: skeletal muscle which is connected to bone and helps with voluntary movement, smooth muscle which is found inside organs and helps to move substances through organs, and cardiac muscle which is found in the heart and helps pump blood.

The **reproductive system** allows humans to reproduce. The male reproductive system includes the penis and the testes, which produce sperm. The female reproductive system consists of the vagina, the uterus and the ovaries, which produce eggs. During conception, a sperm cell fuses with an egg cell, which creates a fertilized egg that implants and grows in the uterus. [Related: Awkward Anatomy: 10 Odd Facts About the Female Body]

Our bodies are supported by the **skeletal system**, which consists of 206 bones that are connected by tendons, ligaments and cartilage. The skeleton not only helps us move, but it's also involved in the production of blood cells and the storage of calcium. The teeth are also part of the skeletal system, but they aren't considered bones.

The **respiratory system** allows us to take in vital oxygen and expel carbon dioxide in a process we call breathing. It consists mainly of the trachea, the diaphragm and the lungs.

The **urinary system** helps eliminate a waste product called urea from the body, which is produced when certain foods are broken down. The whole system includes two kidneys, two ureters, the bladder, two sphincter muscles and the urethra. Urine produced by the kidneys travels down the ureters to the bladder, and exits the body through the urethra.

The skin, or **Integumentary system**, is the body's largest organ. It protects us from the outside world, and is our first defence against bacteria, viruses and other pathogens. Our skin also helps regulate body temperature and eliminate waste through perspiration. In addition to skin, the integumentary system includes hair and nails.

6.0 Circulation of Blood

Wounds and Haemorrhages

6.1 Circulation of Blood:

The job of the circulatory system is to move blood, nutrients, oxygen, carbon dioxide, and hormones, around the body. It consists of the heart, blood, blood vessels, arteries and veins.

Average Heart beat /Pulse rate: 72 times per minute

While noticing the pulse we have to observe speed, Strength and Rhythm of pulse.

6.2 Types of Bleeding (Haemorrhage)

- Artery Bleeding – Bright red in colour and flow in jets.
- Vein Bleedings – Dark red in colour and flow continuously.
- Capillary Bleedings – Red in colour and Oozing from all parts of wound.

6.3 Danger of wounds:

It allows precious blood to escape from body.

It permits harmful Bacteria/virus or other injurious agents to enter into body.

- Direct Pressure Method.
- Indirect Pressure Method.

6.4 General Treatment (First Aid) to Wounds:

- Place the victim in sitting/lying position and elevate the injured part if possible.
- Expose the wound and clean the wound and surrounding area but do not disturb blood clot if already there.
- Remove any foreign body which are floating.
- Arrest bleeding by applying pressure directly on the wound or apply constrictive bandage.
- Apply Antiseptic cream, dressing and bandage.
- Immobilize the part where it is possible.
- Give pain relievers and treat for shock.
- Arrange Medical Aid.

6.5 Important Pressure Points:

- Carotid Pressure point on the neck either side of voice box.
- Sub-clavicular P.Ps on the inner end of collar bone.
- Bronchial P.P. on the inner side of upper arm.
- Femoral P.P. on the thigh bone.

6.6 Wounds and Haemorrhage (Bleeding):

Definition: Wound is breakage of skin/tissue.

Types of Wounds:

- a. Contused Wounds

- b. Lacerated Wounds
- c. Punctured Wounds
- d. Incised Wounds.

6.6.1 Wounds:

- Blunt instruments cause contused wounds where there is no opening.
- Lacerated wounds are caused by irregular edges of instruments like glass pieces metal pieces, machine injuries, animal bites and occurrences where the edges of wound is irregular.
- Sharp edged instruments like Razor/knife cause incised wounds where the edge of wound is in straight line.
- Punctured wounds are caused by sharp edged instruments like needles, nails and most of gun-shot wounds where less opening and more deep.

6.6.2 Nose bleeding Treatment:

- Place the victim near a window or against current of air in sitting position with the head slightly bent forward.
- Pinch the junction of the Nose just below the hard part. If available put ice piece over the nose.
- Advise him to use his mouth to breath and avoid breathing through nose.
- Warn him not to blow the nose.
- Do not block the nostrils.
- Arrange medical aid.

6.6.3 Ear bleeding Treatment:

- Place the victim on a suitable place on side-ways, and see that the affected ear is down (if both ears bleeding keep face upward and head little bit low for free drainage of blood).
- Do not block the ear.
- Arrange medical aid.

6.6.4 Internal Bleeding:

Whenever internal organs or blood vessels got damaged and blood comes out through mouth, nose, ears etc. such bleeding is known as internal bleeding.

6.6.4.1 Symptoms:

- Giddiness
- Skin becomes pale, cold and clammy
- Pulse gets rapid but very weak
- Sweating, Thirsty, feels vomiting sensation
- Become unconscious

6.6.4.2 Treatment:

Check-up air-way, breathing and heart if any failure restore them. Lay him on his back and raise the legs by using pillow to enable the blood supply to the brain.

6.6.5 Head Injury:

As a result of head injury blood and brain fluid may flow out of the nose, ear or mouth.

6.6.5.1 Symptoms:

- Giddiness.
- Skin becomes pale, cold and clammy.
- Pulse gets rapid but very weak.
- Sweating, Thirsty, feels vomiting sensation.
- Become unconscious.

6.6.5.2 Treatment:

Ask the person not to blow his nose. Do not pack ear or nose. Lay the patient on the affected side. Ensure tongue should not fall back.

6.6.6 Embedded Objects:

Whether you've stepped on a nail or fallen on broken glass, never try to pull out an object embedded in a wound. Removing embedded objects from a wound may cause more damage and increase bleeding. Instead, follow these tips:

- Place a clean, preferably sterile dressing around the object.
- Build up padding around the object so it doesn't move.
- Secure padding a narrow bandage.
- Get medical help.

7.0 Shock and Its Management; Asphyxia and Artificial Respiration

7.1 Shock:

7.1.1 Definition: Shock is severe depression to vital functions of organs like brain, heart, lungs etc. due to less blood supply to the brain.

Established Shock: Established shock or true shock is due to less blood supply to the brain.

7.1.2 Causes:-

1. Wounds
2. Fractures
3. Burns & Scalds
4. Snake bite
5. Sunstroke
6. Heart attack
7. Dog bite
8. Electrical shock etc.

7.1.3 Signs & Symptoms of Shock;

1. The skin may appear pale and is cool and clammy to the touch.
2. The heartbeat is weak and rapid, and breathing is slow and shallow. The blood pressure is reduced.
3. The eyes lack shine and seem to stare. Sometimes the pupils are dilated.
4. The person may feel Giddiness (symptom), Vomiting sensation, Thirsty.
5. The person may be conscious or unconscious. If conscious, the person may faint or be very weak or confused. On the other hand, shock sometimes causes a person to become overly excited and anxious.

7.1.4 Precautions after shock:

- a. Get the person to lie down on his or her back and elevate the feet higher than the person's head. Keep the person from moving unnecessarily.
- b. Keep the person warm and comfortable. Loosen tight clothing and cover the person with a blanket. Do not give the person anything to drink.
- c. If the person is vomiting or bleeding from the mouth, place the person on his or her side to prevent choking.
- d. Treat any injuries appropriately (bleeding, broken bones, etc.).
- e. Summon emergency medical assistance immediately

7.2 Heart Attack:

The term covers coronary thrombosis coronary obstruction, myocardial infarction and other forms of heart disease.

7.2.1 Symptoms & Signs:

- Sudden crushing, vice-like pain in the centre of the chest (Sometimes described as severe indigestion) which may spread to the arms, throat, jaw, abdomen or back, and does not subside with rest.
- Sudden dizziness or giddiness causing the casualty to sit down or lean against a wall.
- Skin may be ashen, lips and extremities may become blue (Cyanosist)
- Profuse sweating may develop.
- Breathlessness can occur.
- Fast pulse, which becomes weaker and may become irregular.
- Symptoms and signs of shock.
- Unconsciousness may develop.
- Breathing and heartbeat may stop.

7.2.2 Treatment:

- If the casualty is conscious, gently support and place him in a half-sitting position with his head and shoulders supported and his knees bent.
- Do not let him move unnecessarily as this will put extra strain on his heart.
- Loosen any constricting clothing around his neck, chest and waist.
- Check breathing rate, Pulse and level of responsiveness at 10-minute intervals.
- If he becomes unconscious, open his airway and check breathing. Complete the ABC of Resuscitation if required and place him in the Recovery Position.
- Arrange urgent medical aid or removal to hospital. Transport as a stretcher case, maintaining the treatment position.
- Mouth to Mouth Method of Artificial Respirations:
- Place the casualty on his back on a plain and hard surface.
- Sit by the side of the face, place the hand by the side of chin, and push it farther so that clear ventilation at throat.
- Cover the casualty's mouth with clean cloth and pinch the nostrils.
- Open your mouth, take fresh air, cover the lips of casualty with your lips, and blow the air into the mouth of casualty @ 10-12 times per minute.
- While blowing ensure that nostrils are pinched and chest is rising. If chest is not raising it indicates some obstruction in air passage clear the air passage and restart Mouth to Mouth artificial respiration. This process to be continued until the normal is resumed or Doctor arrives whichever is earlier.
- Mouth to Nose method of artificial Respiration: - In this method blow the air into the nose of the victim by closing the mouth of the victim with fingers.

7.2.3 When Heart Stops Functioning:

If the Heart is not working you will notice the following.

- The face is blue or pale.
- Heart beat and pulse at the root of Neck (carotid pulse) are not felt.

Note:

- Even if the casualty is breathing but the breathing is not normal, it is wise to start Artificial respiration.

- Do not begin Heart compression until you are sure that the heart has stopped beating.

7.3 External heart compression or cardiac massage (CPR):

- Place the casualty flat on his back on a hard surface and remove the cloths over the chest.
- Feel and mark the lower part of the sternum.
- Place the heel of your left hand on the marked point make sure that the palm and fingers are not in contact with chest.
- Place the heel of the right hand over the left hand.
- With your right hand heel press the sternum towards the spine. It can be pressed upto 1 to 1.5 inches.
- Adults should be given about 60 pressures per minute. For children from 2 to 10 years pressure with one hand heel will be enough, but pressure should be
- @ 80-90 times per minute. For infants below 2 years pressures with two fingers is good enough and applied at a rate of 100 times per minute.
- Press firmly but carefully, carelessness may cause injury to ribs.

If the treatment is effective colour will become normal.

- Pupil will contract.
- Carotid pulse begins.
- When pulse is not restarted, continue compression till the patient reaches the hospital or Doctor arrives the spot.

If there is one first aider give 2 inflations of artificial respiration and then give 15 heart compressions and repeat the process.

If there are two first aiders, 1st person will give two inflations of artificial respiration then 2nd person will give five times heart compressions and repeat the process till the normal is resume or doctor arrives whichever is earlier.

8.0 Fractures

8.1 Definitions:

- Fracture is breakage, crack/bend of a bone.
- Dislocation is displacement of one or more bones from joint.
- Sprain is wrenching tearing of cartilage near a movable joint.
- Strain is over lapping of muscles at a particular place.
- Cramp sudden painful involuntary contraction of voluntary muscles.

8.2 Fractures:

8.2.1 Causes: Direct Force, Indirect force and Muscle action.

8.2.2 Signs and symptoms -

- a. Pain
- b. Tenderness (Sever pain by gentle touch)
- c. Swelling
- d. Loss of power
- e. Deformity (Bending/breaking into pieces)
- f. Crepitus (bonny grating sounds)
- g. Unnatural movements.
- h. Irregularity (by touching or comparing with other limb)

8.2.3 Types of Fractures:-

- Simple Fracture: The broken ends of the bone do not out open the skin and thus remain inside only.
- Compound Fracture: When the fractured bone is in contact with outside air as a result of an injury.
- Complicated Fracture: In addition to the fracture, an important internal organ like the brain or major blood vessel, the spinal cord, lungs, liver, spleen etc. may also be injured.

8.2.4 First Aid tips for Fractures:

- Steady and support the injured limb. Do not move the person.
- Dress wounds and control bleeding.
- Check for circulation beyond the site of the fracture. If impaired, get medical help quickly.
- If the injured person must be moved from the site, secure the limb with padded splints and bandages.
- Reassure the injured person, and keep him warm.
- Give pain relievers and treat for shock if necessary.
- Arrange medical aid as early as possible.

8.3 Sprain and Strain Treatment:

- Place in suitable position and put firm bandage and in case of strain wet it with water frequently.
- Arrange medical aid.

10.0 Principles of Accident, Causation and Its Prevention

Unsafe Acts and Unsafe Conditions

Safety is a situation of being safe or an accident free situation. An industrial accident may be defined as an event, detrimental to the health of a man suddenly occurring and originating from external sources, and which is associated with the performance of a paid job, accompanied by an injury followed by disability or even death. An accident may happen to any employee under certain circumstances.

10.1 Causes of accidents:

- Technical causes -unsafe conditions-mechanical/environmental factors
- Human causes-unsafe acts-personal factors.

10.1.1 Mechanical:

- Unsafe mechanical design or construction.
- Hazardous arrangement (piling, over loading).
- Improper machine guarding.
- Unsafe apparel.
- Defective agencies or devices.
- Improper material handling.
- Broken safety guards.
- Protruding objects.
- Leaking acid valves.
- Untested boilers or pressure vessels.

10.1.2 Environmental factors:

- Too low temperature to cause shivering.
- Too high temperature to cause headache and sweating.
- Too high humidity to cause discomfort.
- Defective and inadequate illumination.
- Presence of dust and fumes.
- High speed of work due to huge work load.
- More number of working hours.
- Inadequate rest pauses.
- Noise, bad odour.
- Poor housekeeping.

10.1.3 Personal factors:

- Age
- Health.
- Number of dependents.
- Financial position.

- Home environment.
- Lack of knowledge and skill.
- Improper attitude towards work.
- Incorrect machine habits.
- Carelessness and recklessness.
- Day –dreaming and in attentiveness.
- Fatigue.
- Emotional in stability.
- High anxiety level.
- Mental worries.
- Unnecessary exposure to risk
- Non-use of safety devices.
- Working at unsafe speeds.
- Improper use of tools.

10.2 Accident Prevention:

Accident prevention is highly essential in an industry, in order to

- (i) Prevent injury to and premature death of employees.
- (ii) Reduce operating and production costs.
- (iii) Have good employer-employee relations.
- (iv) High up the morale of employees.

Above all prevention of accidents is a true humanitarian concern. Accident prevention does not occur by itself; there should be consistent implementation of safety measures and safety

Programmes emphasizing the need for

- a. Safe workplace layout and working conditions.
- b. Safe material handling.
- c. Personal protective devices.
- d. Safety activities in the organization.

10.3 Safe Workplace Layout and Working Conditions Layout:

Although most accidents take place because of unsafe act of the employees, the role of the environments and surroundings cannot be ignored in determining the cause of accident. A good layout and working conditions play a major role in preventing many accidents which would have otherwise occurred.

For preventing accidents, the *layout* should be such that:

- Every employee has enough space to move and operate.
- Passageways between working places, roads, tracks and alleys etc., must never be obstructed.

- It prevents the inrush of cold/hot air and draughts to the working place.
- For adequate lighting, ventilation, etc., the heights of the working rooms should be of 3 metres.
- Floors must be of non-skid type, satisfactorily plane and must possess such
- Properties that they can be easily cleaned and absorb sounds.
- Windows should be of adequate dimensions in order to make full use of natural day light.
- Doors and gates leading to open should be provided with ' guards, etc., to prevent draughts at the neighbouring workplaces.
- Fire hazards can be reduced by utilizing fire walls to separate manufacturing area into several compartments.
- A worker operating on the machine should have easy access to the safety switches provided on the machine/near workplace.

Working Conditions:

- In enclosed rooms, in order to have comfortable conditions, the following should be controlled:
- Air temperature, air purity, velocity of air, humidity of air and heat radiations between bodies of different temperatures.
- Not only in enclosed rooms, even otherwise proper ventilation is a must if the manufacturing processes give rise to dust, smoke, fumes etc.
- Whether natural or artificial, there should be sufficient illumination, of adequate colour of light, continuous and uniform and free from glare.
- A high noise level at the workplace impairs men at work and may even endanger them. Noise develops from riveting, grinding, forging, engines, compressors, etc. To reduce noise level and to minimize detrimental effects (e.g. deafness arising out of it,
 - a. Select, purchase and make use of machines and processes which produce little noise.
 - b. Isolate and keep noise producing machines in separate closed cabins.
 - c. Use silencers to minimize the hissing sound of compressed air escaping from blow-off valves in pneumatic tools and machines.
 - d. Use suitable machine mounts to damp down the vibrations.

10.4 Safe Material Handling:

- Careless handling of heavy materials and components is a major source of back and foot injuries.
- To avoid premature fatigue of transport workers, full use should be made of mechanized materials handling equipment.
- Use mechanical means of conveyance to ensure the safety of men engaged in material handling.
- The transport workers should not be asked to lift more than the permissible load, e.g., for a boy of 16 to 18 years of age, this load is 19 kgs.
- During transport, sharp materials, sharp edged goods, poles, etc. should be

- covered, placed in stable holders and retained by means of wire.
- Goods should be piled up such that they do not collapse due to impact or vibrations.
 - Containers or vessels employed to transport liquids or small parts
 - a. should not be too large to limit the range of vision and impede lifting and carrying,
 - b. should be light, and
 - c. Should not be defective/leaking
 - Depending upon the condition of material use a proper material handling equipment, (Refer Chapter on Material Handling). .
 - All material handling equipment should be promptly repaired and adequately maintained on priority basis.

10.5 Personal Protective Devices:

(a) Protection of head

- Safety hard hats.
- Rubberized hats for protection against liquids (chemicals). -Ear protectors.

(b) Protection of face

- Face mask.
- Face shields.
- Welding helmets.

(c) Protection of Eye

- Goggles of case-hardened and clear glass for protection against impact.
- Eye cup goggles for protection against flying objects and dust.
- Eye cup goggles impervious to chemicals for protection against acids/alkalies splashes.

(d) Protection of lungs

- Airline respirators.
- Cartridge respirators.
- Oxygen or air-breathing apparatus.
- Gas mask.

(e) Protection of other body parts, e.g., hand, foot, leg, etc

- Protective asbestos clothing.
- Gloves.
- Safety shoes.
- Foot guards.
- Safety body belt.
- Aprons.
- Safety (moulder's) shoes.

11.0 Housekeeping & Material Handling

11.1 Housekeeping:

Effective housekeeping can eliminate some workplace hazards and help get a job done safely and properly. Poor housekeeping can frequently contribute to accidents by hiding hazards that cause injuries. If the sight of paper, debris, clutter and spills is accepted as normal, then other more serious health and safety hazards may be taken for granted.

Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly; maintaining halls and floors free of slip and trip hazards; and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of accident and fire prevention.

Effective housekeeping is an ongoing operation: it is not a hit-and-miss clean-up done occasionally. Periodic "panic" clean-ups are costly and ineffective in reducing accidents.

11.2 Purpose of workplace housekeeping:

Poor housekeeping can be a cause of accidents, such as:

- tripping over loose objects on floors, stairs and platforms
- being hit by falling objects
- slipping on greasy, wet or dirty surfaces
- striking against projecting, poorly stacked items or misplaced material
- cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

11.3 Benefits of good housekeeping practices:

Effective housekeeping results in:

- reduced handling to ease the flow of materials
- fewer tripping and slipping accidents in clutter-free and spill-free work areas
- decreased fire hazards
- lower worker exposures to hazardous substances (e.g. dusts, vapours)
- better control of tools and materials, including inventory and supplies
- more efficient equipment clean-up and maintenance
- better hygienic conditions leading to improved health
- more effective use of space

- reduced property damage by improving preventive maintenance
- less janitorial work
- improved morale
- improved productivity (tools and materials will be easy to find)

11.4 Good Housekeeping Program:

A good housekeeping program plans and manages the orderly storage and movement of materials from point of entry to exit. It includes a material flow plan to ensure minimal handling. The plan also ensures that work areas are not used as storage areas by having workers move materials to and from work areas as needed. Part of the plan could include investing in extra bins and more frequent disposal.

The costs of this investment could be offset by the elimination of repeated handling of the same material and more effective use of the workers' time. Often, ineffective or insufficient storage planning results in materials being handled and stored in hazardous ways. Knowing the plant layout and the movement of materials throughout the workplace can help plan work procedures.

Worker training is an essential part of any good housekeeping program. Workers need to know how to work safely with the products they use. They also need to know how to protect other workers such as by posting signs (e.g., "Wet - Slippery Floor") and reporting any unusual conditions.

Housekeeping order is "maintained" not "achieved." Cleaning and organization must be done regularly, not just at the end of the shift. Integrating housekeeping into jobs can help ensure this is done. A good housekeeping program identifies and assigns responsibilities for the following:

- clean up during the shift
- day-to-day clean-up
- waste disposal
- removal of unused materials
- inspection to ensure clean-up is complete

Do not forget out-of-the-way places such as shelves, basements, sheds, and boiler rooms that would otherwise be overlooked. The orderly arrangement of operations, tools, equipment and supplies is an important part of a good housekeeping program.

The final addition to any housekeeping program is inspection. It is the only way to check for deficiencies in the program so that changes can be made. The documents on workplace inspection checklists provide a general guide and examples of checklists for inspecting offices and manufacturing facilities.

11.5 Elements of an Effective Housekeeping Program:

11.5.1 Dust and Dirt Removal:

- In some jobs, enclosures and exhaust ventilation systems may fail to collect dust, dirt and chips adequately. Vacuum cleaners are suitable for removing light dust and dirt. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt may accumulate.
- Special-purpose vacuums are useful for removing hazardous substances. For example, vacuum cleaners fitted with HEPA (high efficiency particulate air) filters may be used to capture fine particles of asbestos or fibreglass.
- Dampening (wetting) floors or using sweeping compounds before sweeping reduces the amount of airborne dust. The dust and grime that collect in places like shelves, piping, conduits, light fixtures, reflectors, windows, cupboards and lockers may require manual cleaning.
- Compressed air should not be used for removing dust, dirt or chips from equipment or work surfaces.

11.6 Employee Facilities:

Employee facilities need to be adequate, clean and well maintained. Lockers are necessary for storing employees' personal belongings. Washroom facilities require cleaning once or more each shift. They also need to have a good supply of soap, towels plus disinfectants, if needed.

If workers are using hazardous materials, employee facilities should provide special precautions such as showers, washing facilities and change rooms. Some facilities may require two locker rooms with showers between. Using such double locker rooms allows workers to shower off workplace contaminants and prevents them from contaminating their "street clothes" by keeping their work clothes separated from the clothing that they wear home.

Smoking, eating or drinking in the work area should be prohibited where toxic materials are handled. The eating area should be separate from the work area and should be cleaned properly each shift.

11.7 Surfaces:

Floors: Poor floor conditions are a leading cause of accidents so cleaning up spilled oil and other liquids at once is important. Allowing chips, shavings and dust to accumulate can also cause accidents. Trapping chips, shavings and dust before they reach the floor or cleaning them up regularly can prevent their accumulation. Areas that cannot be cleaned continuously, such as entrance ways, should have anti-slip flooring. Keeping floors in good order also means replacing any worn, ripped, or damaged flooring that poses a tripping hazard.

Walls: Light-coloured walls reflect light while dirty or dark-coloured walls absorb light. Contrasting colours warn of physical hazards and mark obstructions such as pillars. Paint can highlight railings, guards and other safety equipment, but should never be used as a substitute for guarding. The program should outline the regulations and standards for colours.

11.8 Maintain Light Fixtures:

Dirty light fixtures reduce essential light levels. Clean light fixtures can improve lighting efficiency significantly.

11.9 Aisles and Stairways:

Aisles should be wide enough to accommodate people and vehicles comfortably and safely. Aisle space allows for the movement of people, products and materials. Warning signs and mirrors can improve sight-lines in blind corners. Arranging aisles properly encourages people to use them so that they do not take shortcuts through hazardous areas.

Keeping aisles and stairways clear is important. They should not be used for temporary "overflow" or "bottleneck" storage. Stairways and aisles also require adequate lighting.

11.10 Spill Control:

The best way to control spills is to stop them before they happen. Regularly cleaning and maintaining machines and equipment is one way. Another is to use drip pans and guards where possible spills might occur. When spills do occur, it is important to clean them up immediately. Absorbent materials are useful for wiping up greasy, oily or other liquid spills. Used absorbents must be disposed of properly and safely.

11.12 Tools and Equipment:

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide orderly arrangement, both in the tool room and near the work bench. Returning them promptly after use reduces the chance of being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

11.13 Maintenance:

The maintenance of buildings and equipment may be the most important element of good housekeeping. Maintenance involves keeping buildings, equipment and machinery in safe, efficient working order and in good repair. This includes maintaining sanitary facilities and regularly painting and cleaning walls. Broken windows, damaged doors, defective plumbing and broken floor surfaces can make a workplace look neglected; these conditions can cause accidents and affect work practices. So it is important to replace or fix broken or damaged items as quickly as possible. A good maintenance program provides for the inspection, maintenance, upkeep and repair of tools, equipment, machines and processes.

11.14 Waste Disposal:

The regular collection, grading and sorting of scrap contribute to good housekeeping practices. It also makes it possible to separate materials that can be recycled from those going to waste disposal facilities.

Allowing material to build up on the floor wastes time and energy since additional time is required for cleaning it up. Placing scrap containers near where the waste is produced encourages orderly waste disposal and makes collection easier. All waste receptacles should be clearly labelled (e.g., recyclable glass, plastic, scrap metal, etc.).

11.15 Storage:

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual materials handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one metre (or about three feet) of clear space under sprinkler heads.

Stacking cartons and drums on a firm foundation and cross tying them, where necessary, reduces the chance of their movement. Stored materials should not obstruct aisles, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.

Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose. Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your jurisdiction.

11.16 Material Handling:

A material handling for long has been considered as an activity of lifting, shifting and placing of any material regardless of size, form and weight. However, with the growing complexities of the production operations, a need has been felt to integrate the materials handling function with the production operation and control production control functions. The function of production control in any enterprise is to optimise the production within the limitations imposed by manufacturing and marketing conditions. It determines factors like what is to be done, where it is to be done, how it is to be done and when it is to be done. Whereas materials which are to be moved as per the schedules of manufacturing and production control. The procedures, actions and evaluations used in controlling the movement of materials create a strong link between the functions of materials handling, production operations and production control. Realisation of this integrated systems approach offers a great

opportunity for the reduction in production delays and costs in the industry. Materials Handling is, therefore, now being considered as Preparation, Placing and Positioning of materials to facilitate their movement or storage. It relates to every aspect of product except the actual processing".

11.17 Definition of Material Handling:

The American Society of Mechanical Engineers (ASME) has approved the following definition: "Materials Handling is the art and science involving the moving, packaging and storing of substance in any form." A few other representative definitions mentioned elsewhere are:

Materials handling is the creation of time and place utility in a material. Materials handling IS the lifting, shifting and placing of materials, which effect savings in money time and place.

11.18 Materials Movement Management:

The growing complexities of the production processes, the increasing competitive practices within the industry and in the country, coupled with the rising cost of labour has led to increased awareness in managers and engineers about the application of materials handling techniques to cut down the unit cost of production and to increase the productivity in the enterprises. There are a number of success stories, but the desired situation is yet to be obtained. It can be inferred that past approaches to materials handling have frequently led to lessening the magnitude of the problem rather than completely solving the same. Even now idle lying handling equipment or machines waiting for handling equipment are very common sight in our industries, especially in engineering and construction units. This can possibly be attributed to the fact that the approach to materials handling, though sometimes claimed to be systems oriented, has mostly been fragmented and ultimately, equipment-oriented.

Growing number of materials handling equipment manufacturers in India, easy availability of the equipment, flexibility in usage, and intensive sales campaign have resulted in the undesirable tendency to confuse the materials handling system with the use of mechanical aids to the handling. Of course, in many a situation the mechanisation can be useful and increase the efficiency of the system but a quick jumping in this direction takes away the opportunity for a logical and a procedural analysis. The central point of focus then becomes, "How to handle" which leads to "What type of equipment should be used" and this often, results in purchase of some adhoc equipment which suits the budget only or is being used in similar conditions elsewhere. Whereas the concern should be on "Systematic Movement Analysis"

and "Management Requirement Analysis" wherein "Handling Analysis" forms only a part of the exercise.

"Materials Movement Management" thus, is a broader concept covering the analysis, integration, coordination of Production Management System, Materials Management, Materials Handling, Facility Planning and Plant Engineering into an interlinked framework with a view to achieving optimum cost of movement and storage of materials to meet the production and delivery schedules of the company."

The approach based on Materials Movement Management focuses attention on the four aspects viz. material, moves, methods and management.

The basic analysis should therefore, be as follows:

11.19 Material Handling Principles:

Some of the major principles in the design of an efficient system of materials handling are:

(a) Reduce handling to a minimum

As far as possible materials should always move towards completion, over, the shortest distance without back-tracking. Often materials move back and forth over large distances unnecessarily. A large amount of handling can be eliminated by planning the location of operations so that one operation finishes right where the next begins. The flow of product should receive top priority in planning of layout.

(b) Avoid re-handling

It may not be possible to eliminate re-handling completely, nevertheless re-handling is a wasteful and costly operation. Re-handling can be reduced by (i) not keeping anything on floor, (ii) avoiding transfers from floor to container or vice versa or from container to container and (iii) avoiding mixing of materials.

(c) Combine handling with other operations

Many times handling may be, made a productive activity by combining with other operations, such as production, inspection, and storage. In process industries, materials undergo physical and chemical changes while in movement, handling devices may be used as live storages or materials may be sorted and inspected while they are being handled.

(d) Ensure safety in handling

Safety is a key word in handling. A large percentage of industrial accidents

are attributed to poor handling practices. Even more costly in terms of money in the damage to equipment and products due to improper handling methods. A good handling system should ensure safety to walkers and materials. Manual handling of heavy objects materials scattered on floor or projecting into aisles are but a few causes of accidents. Keeping gangways and aisles clear is one of the primary precautions against accidents in handling.

(e) Handle materials in unit loads

It is easier and quicker to move a number of materials at a unit rather than piece by piece. Modern material handling devices are designed to take advantage of unutilised loads.

(f) Use gravity where possible and mechanical means if necessary

The simplest and cheapest way to handle materials is by using gravity.

Often chutes and inclined boards can conveniently used to transport materials quickly to the point of use about much investment on costly handling equipment. Where it is not possible to use gravity for various practical reasons, some mechanical means should be considered. Lifting and carrying of heavy materials mechanically saves time and reduces fatigue of workers.

(g) Select proper handling equipment

There are as many types of handling equipment available today as the number of materials to be handled. And any single equipment may not solve all handling problems. It is therefore, necessary to choose the equipment suitable for the job under consideration. The equipment selection needs to be done carefully so that there is an efficient coordination of all handling, resulting in overall economy. Use of standardized equipment facilitates maintenance and repair.

Another important factor in the selection of equipment is flexibility.

Industrial activity is subject to constant changes and handling equipment should provide for this change. In other words, the equipment selected, should be capable of a variety of uses and applications.

(h) Reduce terminal time of equipment

The advantage of mechanical and power equipment would be lost if they are made to wait during loading and unloading this may take considerable amount of

time. By reducing this waiting time the handling equipment could be released for more productive work. There are various mechanical devices like trailers; tipping arrangements, cranes and hoist attachments, to quicken loading and unloading operations.

(i) Buy equipment for overall savings

In selecting equipment savings in overall handling cost must be the guiding principle rather than the first costs of equipment. Arriving at handling costs is a difficult problem but a fairly accurate estimate can be obtained by determining the handling elements and applying work measurement.

In India labour is still comparatively less costly and a longer period may have to be allowed for amortizing the handling equipment. All direct and indirect savings are to be taken into consideration while deciding on handling equipment.

(j) Use labour consistent with handling methods

Manual handling could be done by unskilled labour, whereas mechanical handling may require semi-skilled or skilled workers. Proper allocation of skills helps in overall economy. As far as possible direct production operators should not be used for handling operations. It is preferable to have a separate gang of material handlers to ensure proper utilization of production workers.

(k) Train workers and maintain equipment

Careful operation and proper upkeep are essential for getting the maximum out of the handling equipment. Careful selection and training of employees in principles, operation and safety rules and planned maintenance of equipment are 'worthwhile investments in the long run.

11.20 Efficient Material Handling:

Use of right method to provide right amount of right material at the right time in the right sequence, right position, right condition and at right cost.

11.21 Types of Material Handling Equipment:

The material handling equipment are classified under 5 categories.

11.21.1 Conveyors:

Used to move the material between two fixed stations either continuously or intermittently.

1. Roller Type

2. Wheel Type
3. Bucket Type
4. Screw Type

11.21.2 Industrial Trucks and Trolleys:

Moving materials in a shop floor in a flexible manner.

1. Trolleys
2. Motor Trucks
3. Fork Lifts
4. Platform Truck

11.21.3 Cranes:

Moving the material on over head space without disturbing workers.

Examples: Jib cranes, Bridge cranes, Circular cranes

11.21.4 Hoists: Chain hoists, Electric hoists, Pneumatic hoists

11.21.5 Containers:

Dead Container: Contains material but not moved

Live Container: Contains material and can be moved

E.g. Power trucks, wagons etc.

12.0 SAFETY ON SMALL TOOLS AND ELECTRICAL APPLIANCES

12.1 SAFETY PRECAUTIONS TO BE FOLLOWED WHILE WORKING WITH ELECTRICAL HAND TOOLS & GADGETS.

- a) The electrical hand tools should be of good construction with certification from BIS or any other international agency similar to BIS working on 110V, 50 cycles per second (AC) supply.
- b) The cable connected to the machine tool should be of good quality double insulated three-core type, so that proper earth is made effectively. The cable end should have been connected to a 3 pin top. The cable should not have joints. All long cables with joints should have proper protection.
- c) The electrical circuit should be checked for earth before commencement of work.
- d) The work should be carried out only by trained personnel. They should wear Safety shoes without nails. They should wear panoramic goggles or spectacle type goggles with side covers while working with portable drilling & grinding machines to avoid eye injury.
- e) The cable should not be left on the floor where there is chance of running over by trolleys having metal wheels or chance of falling of metal scrap from height on the cable.

12.2 Hand Tools:

Have no power source, other than the physical force applied by user. Hand Tools include anything from axes to hammers and screwdrivers and wrenches.

12.3 Power Tools:

Require a non-human power source to function properly.

Eg: External – Electricity, Compressed Air etc

Internal – Battery Pack, Internal Combustion Engine etc

Both kinds of tools requires specific safety precautions or rules to be followed; yet some rules will apply to both.

There are 5 basic rules that apply to all tools either hand or power.

- Keep all tools in good working order
- Use the tool only for what it is designed to do
- Examine the tool for damage before each use
- Always follow the manufacturer instructions when operating any tool
- Always wear the appropriate PPE when operating any tool

12.4 Hand Tool Safety Rules:

- Tag worn, damaged or defective tools and do not use them

- Carry all sharp tools in a holster or sheath
- Do not perform make shift repairs to tools
- Do not use cheater bars
- Do not throw tools from one location to other or from one employee to another
- When working on ladder or scaffolding be sure you and your tools are secure
- Do not carry tools in your hands while climbing, use a tool belt or host the tools by using hand line

12.5 Greatest Hazards of Hand Tools: Misuse / Improper Maintenance

- Using a screwdriver as a chisel could cause the tip to break and fly, hitting either the operator or bystanders
- A wooden handle on such as a hammer or an axe is loose, splintered or cracked, the tool head could fly off and strike the operator or bystanders
- Impact tools, e.g. chisels and wedges, are unsafe if their heads are mushroomed. The heads might shatter on impact sending sharp fragments by flying
- Wrenches must not be used if the jaws are sprung, cracked or twisted, the wrench could slip off

12.6 Safety Rules for Specific Hand Tools:

12.6.1 Hammers:

- Use a claw hammer for pulling nails
- Do not strike a hard end steel surface with claw hammer
- Do not strike one hammer against other
- Do not use a hammer as a wedge or pry-bar

12.6.2 Chisels:

- Use chisels that are sharp
- Do not chisels with a mushroom head
- Use only hammers that are designed for use with chisels

12.6.3 Saws:

- Do not carry the saw by the blade
- Do not use any saw that has a dull saw blade
- Keep control of the saw by releasing downward pressure at the end of each stroke

12.6.4 Screwdrivers:

- Always ensure the screwdriver fits the head of the screw
- Do not hold the work piece against your body while using the screwdriver
- Do not use a screwdriver as a punch, chisel, pry-bar or nail puller
- Do not use a screwdriver to test the charge of a battery
- Use blue handled screwdrivers when working on electrical
- Do not use a screwdriver to make a starting hole for screws

12.6.5 Wrenches:

- Do not use wrenches that are bent, cracked, or that have loose handles
- A hammer may be used for striking “face wrenches” only
- If at all possible use socket or box wrenches
- Do not use a cheater bar

12.6.6 Snips:

- Wear safety glasses or goggles when using snips
- Wear work gloves when cutting material with snips
- Do not use snips as a hammer, screwdriver, wrench or pry-bar
- Use the correct type of snips for the job

12.7 Power Tool Safety Rules:

- Do not use power tools you are not trained on
- Do not lift or carry power tools by their power cord
- Keep power cords out of the paths of the power tool
- Do not leave tools unattended
- Do not stand in water or wet surfaces when running a power tool
- Hold all power tools by the plastic hand grips or other non-conductive areas
- Do not plug multiple electrical cords into a single outlet
- Do not use power tools or extension cords with a missing prong
- Ground all tools unless double insulated
- Be aware of all power lines, electrical circuits and water pipes that are not visible
- Do not wear loose clothing, dangling objects or jewellery. Long hair must be restrained
- All observers should be kept a safe distance from the work area

12.8 Abrasive-wheel tools:

Powered abrasive grinding, cutting, polishing and wire buffing wheels create special safety problems because they can throw off flying fragments.

- Before an abrasive wheel is mounted, it should be inspected closely and sound or ring tested to ensure it is free of cracks or defects
- To test wheels, tap them with a light non-metallic instrument.
- If they sound “cracked or dead” do not use them. They could fly apart
- Always use the right wheel or cup for the job you are performing. Be sure to match the “RPM rating” with tool.

Finally, pay close attention any “special warnings”, that the manufacturer may offer, such as “do not use in wet or high moisture conditions.”

12.9 Circular Saws:

- Always wear safety goggles or safety glasses with side shields
- Use a dust mask, especially when cutting treated woods
- Wear hearing protection, especially during extended periods of operation
- Use sharp blades, dull blades cause binding, stalling and possible kickbacks
- Use the correct blade for the job
- Ensure the blade guard is in working order, never remove it or tie it back
- Avoid cutting small pieces that can't be properly secured or the saw shoe can't properly rest

12.10 Drills:

- Be sure the chuck is securely tightened to the spindle
- Tighten the bit securely and remove the chuck key
- Always hold or brace the tool securely and use any auxiliary handles if provided
- Don't force a drill. Apply only enough pressure for the bit to do the cutting

12.11 Miter / Chop Saws:

- Because of the saw's downward cutting motion, be sure to keep hands and fingers out of the blades path
- Be sure all guards are in place and working

Ensure that the recommended size and RPM blades are being used

13.0 Factories Act – 1948

&

Employee Compensation Act, 1923

13.1 Factories Act:

This Act lays down the obligation of the occupier of a factory in the matters of cleanliness of disposal of wastes and effluents, maintenance of proper ventilation and temperature prevention of overcrowding, provision of cool drinking water, latrines and Urinals, fencing of machinery, maintenance of machines in safe condition, pre-cautionary measures against fire hazard, provisions of washing facilities, fixing of weekly holidays and payment of overtime allowance. Prevention of accidents etc.

a) factory is a place where manufacturing operations are carried out with or Without power, Where on 10 or more worker are working on any day the preceding 12 months and in any part of which a manufacturing process is being carried out with the aid of power or any premises where on 20 or more are working on any day of preceding 12 months and in any part of which a manufacturing, process is being carried out without the aid of power and it should be registered with state government and license obtained.

b) Occupier means the persons who has ultimate control over the affair of factory and in case such affairs are entrusted to a manager such manager shall be deemed to be the occupier.

c) Worker is a person employed in a factory either for wages or otherwise, who is engaged for manufacturing operation, or any kind Of work incidental to or connected with manufacturing process. Children below the age of 15 years should not be employed in a factory or workshop.

d) Hours of work: 48 hours in a week, 9 hours in a day, Period of work shall not exceed 5 hours at a time, an interval of 1/2 half hours shall be given. The spread over including the rest period shall not be more than 10-1/2 hours in a day. Over time shall be paid at the rate of twice his ordinary rate of wages and not more than 60 hours in a quarter. No women should work between 7 p.m to 6 a.m.

e) Rest Day: if a worker works continuously for 6 days he shall be entitled for one day rest and is the rest cannot be given then 11th day must be granted rest. Rest can be granted either 3 days advance or three days later. Normally rest should fall on Sunday.

f) Other provisions: First Aid Box for every 150 workers. One Ambulance for more than 500 workers, a welfare Officer for more than 500 workers and provisions of canteen for more than 250 workers.

Purpose & Object	Factories Act, 1948 has been enacted to regulate the working conditions in factories and to ensure provision of the basic minimum requirements for safety, health and welfare of the workers as well as to regulate the working hours, leave, holidays, employment of children, women, etc.
Applicability	Factories Act, 1948 extends to whole of India. It applies to factories as defined under the Act.
Coverage	Any premises including the precincts thereof where 10 or more workers are or were working on any day of the preceding 12 months and in any part of which a manufacturing process is being carried on with the aid of power or is ordinarily so carried on; or Any premises including the precincts thereof where 20 or more workers are or were working on any day of the preceding 12 months and in any part of which a manufacturing process is being carried on without the aid of power or is ordinarily so carried on

Working Conditions in Factories						
Categories of Workers →		Adult Workers		Adolescent		Children
Working Conditions ↓		Men	Women	Male	Female	
Hours of Work		Not more than 9 hours in a day and 48 hours in any week	Not more than 9 hours in a day and 48 hours in any week	Not more than 9 hours in a day and 48 hours in any week	Not more than 9 hours in a day and 48 hours in any week	Not more than 4½ hours in a day
Working Hours	Any time		Between 6 A.M. and 7 P.M. State Governments may modify the limit by notification;	Having Certificate of Fitness to work in a factory and having attained the age of 17 years: Any	Between 6 A.M. and 7 P.M. State Governments may modify the limit by notification; but in no	For male child: Between 6 A.M. and 10 P.M. For female child: Between 8

		but in no case, any women may be employed between 10 P.M. and 5 A.M.	time Having Certificate of Fitness to work in a factory but not having attained the age of 17 years: between 6 A.M. and 7 P.M.	case, any female adolescent may be employed between 10 P.M. and 5 A.M.	A.M. and 7 P.M. No child is permitted to work during night
Overtime	In case of more than 9 hours of work in any day or 48 hours in any week, the worker shall be entitled to overtime wages at the rate of twice his ordinary rate of wages	In case of more than 9 hours of work in any day or 48 hours in any week, the worker shall be entitled to overtime wages at the rate of twice his ordinary rate of wages	In case of more than 9 hours of work in any day or 48 hours in any week, the worker shall be entitled to overtime wages at the rate of twice his ordinary rate of wages	In case of more than 9 hours of work in any day or 48 hours in any week, the worker shall be entitled to overtime wages at the rate of twice his ordinary rate of wages	N.A.
Interval	At least ½ hour break after every 5 hours of continuous work	At least ½ hour break after every 5 hours of continuous work	At least ½ hour break after every 5 hours of continuous work	At least ½ hour break after every 5 hours of continuous work	N.A.

13.2 Employees Compensation Act:

It provides for payment of compensation to workers in case of accidents involving injuries to them or to their dependents in case of death. The act also provides for a machinery to deal with claims of the workers.

13.2.1 Compensation when payable:

Compensation is payable when the accident causing death/injury arose "out of and in course of employment". In case of injury it must cause a disablement for a period of at least 3 days. In case of temporary disablement the employee is entitled to half monthly payment, and in case of permanent disablement or death to a lump-sum amount on the basis of workmen's monthly wages calculated as per Schedule IV given in the act. The compensation is also payable for such disabilities/death caused due to occupational diseases as given in schedule III of the act.

13.2.2 Employer's pleas not to be applicable:

In a claim of compensation for injury an employer may take pleas like:

- The workman was under the influence of drug or drinks.
- Willful disobedience of orders or disregard of rules made for safety of workers.
- Willful removal or disregard of any safety guard or device.

These pleas however are not applicable in case of the death of the workman.

13.2.3 Important Features:

By a recent change in the Act following important features have been added:

- The term 'Workmen' is replaced by 'Employee'.
- the amount of compensation will now be related to a "relevant factor". What is a relevant factor has been given in Schedule IV.
- Amount spent on medical treatment shall not be deemed as a payment or allowance received by worker.
- All the employees are covered under this act except Group B and Group A officers.

A new and more comprehensive Schedule III of "occupational diseases" has been given.

Liabilities for compensation arises in case of:

- Death
- Permanent total disablement.
- Permanent partial disablement
- Temporary partial or total disablement.

13.2.4 Calculation of Compensation:

Compensation will be calculated as under:

- For death 50% of emoluments X Relevant Factor —(Minimum of Rs.1,20,000) and Rs,.5000 for funeral expenses.
- For permanent total disablement-60% of emolument X relevant factor (Minimum Rs. 1,40,000)
- For permanent partial disablement—Proportionate percentage of item (ii) above will be paid.

13.2.4 Wage Limit:

Where the monthly wages of workman exceed Rs.8, 000, then his monthly wages for the purpose of calculation of compensation shall be deemed to be Rs.8,000 only.

14.0 Role of supervisor on safety, Accident Reporting and Investigation

14.1 Role of Supervisor on Safety:

- In addition to their regular work allotted by the concerned SSE, the following duties to be ensured.
- Daily safety walk around in their shop to find out unsafe actions and unsafe conditions.
- To see that all fire-fighting equipment such as fire buckets and fire extinguishers are in systematic arrangement and at nominated places.
- To attend shop level monthly safety meeting with concerned SSE in charge and Safety officer to discuss day to day safety, health, and welfare problems.
- Daily report to Safety Engineering Department and SSE in charge about any problems which are endanger to industrial safety.
- To submit FIR duly signed by SSE/in charge immediately in case of employee injured. To assist injured employee in filling up of IOD form No 18, and till to submit it to Safety Engineering Department within 24 hours.
- Monitoring first aid boxes conditions and medicines/contents and arrangement of refilling with co-ordination of Welfare Inspector.
- Enforcement of PPE's to be used by regular employees as well as contract laborers in their shop.
- If any works carried out at heights, electrical repair works, excavation work etc. Irrespective of rly staff and contractors in a prescribed format No FT/SFTY/07.Work permit to be obtained from Safety Engineering Department.
- To attend annual safety meeting.
- To participate and make arrangements in active participation of staff in fire demonstration once in 6 months in their shop.
- Monitoring of fire hydrant points are in working condition and good housekeeping.
- Participation in mock drill as per on site emergency plan once in a year as per the date decided by Safety Engineering Department.
- To bring the notice of in charge SSE about the endanger to staff with pressure vessels, EOT crane conditions, forklifts, machines, gas cylinders, wire ropes etc
- Monitoring due/overdue refresher course at BTC.
- Availability of stretcher in In-charge SSE chamber and maintaining it in good condition.

14.2 Accident Reporting:

S. C. Railway Carriage Workshop Lallaguda	Integrated Management System-Format		Doc. No. F/SFT/04	Ref:
	Title:	ACCIDENT / INCIDENT / NEAR MISS REPORT		
	Rev. No.	00	Effective Date:	27/08/2015

Name of the Shop:
Name of the SSE In-charge:
<input type="checkbox"/> Accident <input type="checkbox"/> Incident <input type="checkbox"/> Near Miss
Date of Occurrence: Time of Occurrence:

DETAILS OF INJURED PERSONS:

NAME	Ticket No.	Part of the body Injured	First Aid / Hospital Treatment

Details of machinery / vehicles involved:

SN	Details of Machinery / Vehicle	Details of Driver / Operator
1.		
2.		
3.		

Witness:

SN	Name	Ticket No.	Signature
1	
2	

Details of property damage:

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Details of exact location:

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14.3 Accident Investigation:

S. C. Railway Carriage Workshop Lallaguda	Doc. No:	R/SFT/Incident Investigation Report			Ref. P/16
	Rev. No:	00	Effective Date:	27/07/2015	Page 1 of 1

Section – 1

Type -

Category -

Location -

Time of event -

Section – 2

Description of event

Section – 3

Details of personal injury/Industrial illness –

Section – 4

Cause analysis –

- a) Indicate major operation in progress at the location of event –
- b) Indicate actual activity leading to event –
- c) Indicate what kind of event led to the injury / illness or condition –
- d) Indicate the immediate cause –
 - I) Sub – standard acts/practices –
 - II) Sub – standard conditions –
- e) Indicate underlying or basic cause –
 - i) Personal factor –
 - ii) Job factor –

Section – 5

Estimated cost of loss –

Section – 6

Action to prevent recurrence –

Signature of SSE/Safety:

Date:
