PERSONAL PROTECTION EQUIPMENT

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Course Contents

1.	Introduction
2	Categories of PPE
3	Care, Maintenance & Effective use of PPE
4	Safety in Material Handling.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE) is an important means of preventing work injuries. Ideally, the best approach is to maintain a safe work environment and eliminate any potential hazards.PPE should only be relied upon as a last line of defense in places where it is not practicable to control the hazards at source. Personal protective equipment (PPE) means all equipment which is intended to be worn or held by people at work and which protects them against one or more risks to their health and safety, and any addition or accessory designed to meet that objective. All PPE should be used as a last resort to reduce the risk taking into consideration that the risk will not be eliminated.

The use of PPE generally implies working in a potentially hazardous work environment and its use is a major means of injury prevention. Therefore , it is of prime importance to ensure that the equipment chosen is both reliable and effective, it is being properly used and maintained , and the user has undergone adequate training . The aim of this module is to raise the awareness of occupational safety and health practices and the proper use of PPE. As we all know ‘PPE’ comes last in the control of hazards hierarchy, but cannot be negated, moreover when we all are trying to elevate standards of safety ‘PPE’ plays a pivotal role in addressing safety where hazards are unseen or cannot be quantified: Natural calamities, Fire Services, Military operations-warfare, Disaster Management etc. all these encounter unpredictable and unforeseen situations or emergencies where the only thing which probably works is the courage to face a situation and the preparedness to meet any eventuality and this is possible only thro use of ‘PPE’.

Categories of PPE :

Depending upon the nature of the hazard , the PPE is broadly divided into the following two categories :

1.Respiratory : those used for protection from harm due to inhalation of contaminated air.

2. Non- Respiratory : those used for protection against injury from outside the body,i.e for protecting the head, eye, face,hand ,a arm, foot,leg and other body parts, and

Personal Protective Equipment - Respiratory

It has been observed that exposure to hazardous chemicals in any industrial work place can not be completely eliminated by using various safe technologies and engineering control measures. The workers are, therefore, bound to face some amount of harmful exposures during the course of their work. It has to be kept in mind that there may also be a plant breakdown or sometimes, repairs and maintenance may have to be carried out in the contaminated environment. On such occasion, the level of air contaminants may even exceed the Permissible Limit of Exposure and the working conditions may essentially demand for providing Respiratory Protection devices to the workers. Such exposures are also possible in manual handling and transportation of chemicals. Respiratory protective equipment should be considered as a last resort or as a stand-by protection and never a substitute for effective engineering control measures. It is, therefore, essential that the last line of defence should be most reliable and must not provide a false sense of security to the users It is a well known fact that the toxic effect of a chemical depends on the nature and degree of its hazard potential. As such, for different work situations, different types of respiratory protection devices are required and used.

Classification of Hazards for Respiratory Protection

The various types of hazards to which a worker is exposed in the industry are the main points of consideration for selection of the right type of respiratory protective equipment. These hazards may be classified as given below:

1 Oxygen deficient work environment.
2 Gas or vapour Contaminants.
3 Air borne particulate matter.
4 Mixture of gases, vapours and particulate matter

1. Oxygen deficient work environment :

The presence of inert gases (Nitrogen or Carbon dioxide) in high concentration produces Oxygen Deficient atmosphere. Confined spaces also may have less amount of oxygen than our requirement for breathing purpose. Breathing air with oxygen content of 16% or less may produce symptoms ranging from increased rate of breathing, acceleration of pulse rate, unconsciousness and to death. The flame of a safety lamp, which gets extinguished in such atmosphere, can easily detect such oxygen deficient conditions. The respiratory protective equipment, used in such conditions, should either supply normal fresh air or oxygen to the wearer.

2. Gaseous/ vapour Contaminants

The highly toxic gases or vapours present in breathing air can endanger the life of a person, if exposed, even for a short period of time. High concentration of a gas in the work environment is also immediately dangerous to life. Where it is not possible to determine the extent of concentration or the kind of gas is not known, all gases should be considered as ‘immediately dangerous to life’ As such, supply of fresh air or self contained breathing apparatus should be used. The toxic gases or vapours - when they build up a concentration in the work environment exceeding the Permissible Limit of

Exposure and it is breathed by a worker repeatedly may cause possible health injury after a prolonged exposure. The exposure concentration of the contaminant should, therefore, be known to decide when and which type of respiratory protection device is required to be used.

3. Air borne particulate matter (Dusts, Fumes, Smokes, Mists, and Fogs).

The particulate contaminants may be solid, liquid, or a combination of both. These contaminants may be classified into three broad groups.

a) Nuisance Dust.

The particulate matter which remains in the lungs without producing local or systemic poisoning effects or may dissolve and pass directly into the blood stream without causing any harmful effect are called nuisance dust. Examples of such dust are cement, lime and sawdust.

b) Toxic particulate matter.

Air borne particulate matter **w**hen inhaled may get trapped into to the lungs and subsequently may pass to the blood stream and enter into various parts of the body. The effects may be chemical irritation, systemic poisoning, allergy reaction and cancer. Common contaminants in this group are Antimony, Arsenic, Cadmium, Lead, Manganese, Chromium, Chromate, Dichromate, etc.

c) Fibrogenic Dust

The particulate matter, which has potential to produce fibrosis of the lung tissues is called fibrogenic dust. Examples of such dust are Asbestos, Cotton. Silica powder,etc.

4. Mixture of gases, vapours and particulate matter

The mixture of different types of air borne contaminants like oxides of nitrogen produced by electric arc welding operation and the metal fume generated, as well as the presence of other gases in the work place environment draw special attention for taking a decision in selection of right type of respiratory protection devices. In such situations more effort is required to be made to improve the workplace environment. Priority is required to be given to eliminate some of the contaminants in the most possible and practicable manner and then subsequently to select the right type of a respirator.

Types of Respiratory Protective Equipment

The Respiratory Personal Protective Equipment can be broadly divided into two groups:
1. Air Supplying Respirators (Breathing Apparatus).
2 Air Purifying Respirators

Respirators of various types used in different work situations are discussed below with their main function, utility and limitations.

1. Air Supplying Respirators (Breathing Apparatus)

Breathing Apparatus enables a person to work in a poisonous and contaminated environment for a long or a short period with full physical and mental capacity. It is also known as rescue apparatus, anti - gas apparatus and gas mask. Such breathing apparatus is required in mines, gas works, chemical factories, and oil refineries and in confined spaces. It can also be used by fire brigade, municipality, armed forces and mountaineers. The breathing apparatus should be so efficient and reliable as to ensure the safety of the users in toxic gases, oxygen deficient atmosphere, extreme heat, high humidity, wreckage & fall during disaster. It is therefore, imperative that breathing apparatus should be easy to wear, comfortable to the extent possible, efficient and safe under various conditions including temperature, resistance and have an appropriate design. Good quality of materials and workmanship are the other essential requirements of the breathing equipment. Besides, it should ensure chemical purity of air/oxygen meant for breathing purpose and conform to rigorous physiological, physical, chemical and mechanical tests. Such tests have been prescribed by Bureau of Indian Standard (BIS) for Breathing Apparatus in IS: 10245 (Part I, II, III, IV) –1982

a) Closed Circuit Breathing Apparatus

The exhaled air is re - breathed by the users in closed circuit type of breathing apparatus. The wearer inhales oxygen through a one-way breathing valve and his exhaled breath passes into a canister containing chemicals to absorb exhaled carbon dioxide and moisture and then through a cooler into the same breathing bag. Oxygen enters the breathing bag from the supply cylinder only when the volume of gas in the bag has decreased sufficiently The exhaled carbon dioxide concentration is effectively reduced and the oxygen concentration is enriched. It is used either with a full-face piece or with mouth piece and nose clips.

b) Open Circuit Breathing Apparatus

The wearer gets breathing air from compressed air cylinder through a demand valve in an Open Circuit Breathing Apparatus. In a demand type respirator, air is supplied to a face-piece through a demand valve. The rate is governed by his breathing requirement actuated by the creation of slight negative pressure due to inhalation. On exhalation, the demand valve closes and exhaled air escapes to the surrounding atmosphere through exhalation valve. Helmets or hoods are not attached with demand type respirator.

c) Airline Respirator

Airline respirator consists of a face-piece (half or full mask or a loose fitting helmet or hood) to which air is supplied through a small diameter hose. It may be a continuous supply type or a demand type through compressed air pipelines. In Airline respirators, the length of the air supply hose is so that the air supply is maintained but the wearer's travel movement restricts protection. Care should be taken to ensure that the air supply is always breathable and is not contaminated and free from objectionable odours, oil mist or water vapour and rust particles from the supply line.	

d) Suction Hose Mask

It consists of a full face piece connected to a large diameter flexible hose. The worker draws in air by his own breathing effort. The hose is attached to the wearer's body by a suitable safety harness with safety line and the air inlet end of the hose is provided with a filter to arrest particulate matter. Air can be drawn in by respiratory effort of the wearer up to 30 ft. (9 Metres) length of the hose.

e) Pressure Hose Mask

Pressure hose mask is similar to suction hose mask except that the air is forced through a large diameter hose by a hand or motor – operated blower. The blower is to be operated continuously while the mask is in use. From respiratory point of view, self-contained breathing apparatus **has no limitation as to the concentration of the gas or deficiency in the surrounding atmosphere** but other factors may limit the time that the wearer can remain in a contaminated atmosphere. Many gases are very irritating to the skin and can be absorbed in dangerous amounts through the skin. As such, in some situations, devices for body protection are also required to be used.

2. Air Purifying Respirators Canister type Respirator (Gas Mask)

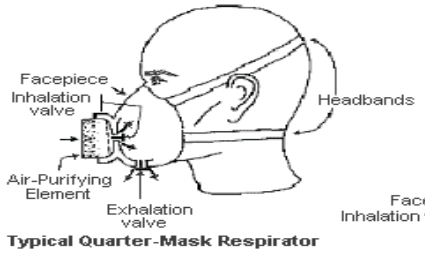
The canister type respirator consists of a canister containing appropriate chemical, a full face-piece and body harness to hold the canister attached to the body of the wearer. Air is drawn through the canister by the wearer's normal inhalation force. The contaminated air passes through the canister and the gases or vapours present in the incoming air is adsorbed in the activated charcoal impregnated with suitable chemicals to neutralize and contain the contaminants. The canisters are designed for specific gases and it is very important that only an appropriate type of canister is used for a specific purpose.

The canister gas mask can only be used in atmosphere not deficient in oxygen and not containing more than 2% by volume of most toxic gases. The life of the canister also depends upon the type of canister, the concentration of gas and the activity of the wearer.

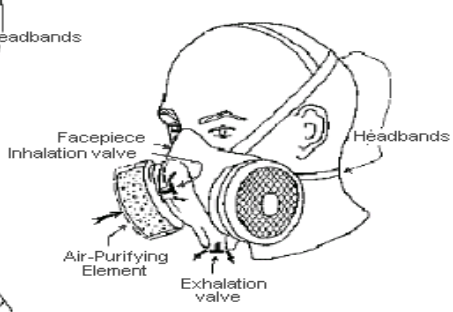
Similar to canister gas mask, chemical cartridge respirator also provides respiratory protection for a period that depends on the type of cartridge used, the concentration of the gas or vapour and the wearer's activity. Cartridge respirators are recommended for low concentration gases and vapours (maximum of 0.1% of organic vapour). For easy identification of the Canister and Cartridge Respirator, specific colour has been assigned to each type of respirator. IS 8318-1977 mentions about the colour identification markings for canister and cartridges. As per IS 8522-1977, a cartridge respirator should not be used beyond the air borne concentration of a chemical.

a) Self-Rescue type Respirators

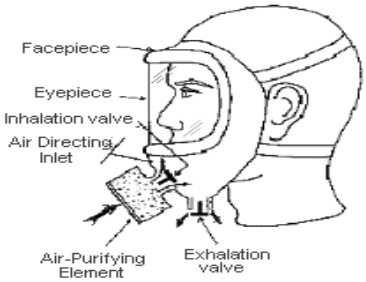
The Self Rescue type respirator is designed to provide the greatest possible respiratory protection consistent with the practicability of carrying the device at all times, so that it is always available for use during escape. It consists of a small filter element, a mouth piece, a nose clip and means for carrying conveniently on the body. The filter elements are similar to chemical cartridges. The extent of protection afforded by self rescue type respirator is between the canister gas mask and the chemical cartridge respirator.



Typical Quarter-Mask Respirator



Typical Half-Mask Respirator



Typical Full-Facepiece Respirator


Quarter Mask


Half Mask


Full Facepiece

b) Mechanical Filter Type Respirators

Mechanical filter type respirators remove particulate matter from the inspired air by allowing the air to pass through a filter. These filters may be for single use or reusable type. If these respirators are used in heavy concentration of particulate matter, the filter will be clogged with dust particles too quickly and it may have to be replaced every now and then. Micro filters are special filters designed to arrest fine dust particles of ultra microscopic size.

c) Combination of chemical & mechanical filter Respirators :\

These respirators are provided with a mechanical filter and a cartridge for the specific gas or vapour to remove toxic gases and vapours as well as particulate matter from the inspired air. These respirators are used in spray painting work, electric arc welding, powder formulation of pesticides, etc.

Selection of Respirator

Respirators are life saving Personal Protective Equipment and hence due care and attention has to be paid while selecting a right type of respirator in a particular work environment. It is necessary to know the type and nature of the air contaminants, level of air borne concentration, severity of the hazard, period for which respiratory protection is required, location of the contaminated are, availability of the fresh air and expected activity of the wearer. In addition, the operating conditions and limitations of the available respirator are also required to be known. Considering the above factors and keeping in view the safety of the persons at work, suitable and appropriate type of respiratory protection device is selected.

Important points to check the quality of respirators

To select the best quality of the respirator, the following important points are required to be considered.

1. All materials used in the manufacturing and assembly of the respirators should have adequate mechanical strength, durability and resistance to deterioration by heat or by contact with sea water or mine water. It should also be antistatic and resistant to fire.
2. Exposed parts/components of the respirators should not be made of metals like magnesium and aluminum or its alloys to avoid frictional sparks capable of igniting flammable gas mixtures.
3. The parts of the respirators which come in contact with should be non staining, soft, pliable and should not contain known dermatitis substances.
4. The respirator should be sufficiently robust to withstand rough usage.
5. The detachable parts should be well designed for easy detachment, cleaning and securely refitting to its main bodies.
6. Adjustable parts of the breathing apparatus should be readily accessible and easily distinguishable from one another even by touch sensation.
7. Face piece of the respirators should cover the eyes, nose, mouth and chin. It should provide adequate sealing on the face of the users against the outside gas during movement of head, speech communication and dry or moist skin. Face piece is not suitable for a person having beard unless it is so designed. Face piece should be light in weight comfortable to wear. It should have adjustable and replaceable head harness.
8. The nose clips should restrict the entry of air contaminants through upper sides of the nose. It should be comfortable in use and easy to fit.
9. The inhalation and exhalation valves should not cause the wearer to apply extra pressure for breathing purpose. The inhalation resistance should not be more than 30 mm of water pressure before test and 50 mm of water pressure after test. The exhalation resistance should not exceed 20 mm of water pressure.
10. Representative samples of the various types of respirators should be tested to ascertain their quality that they conform to the specifications of BIS.

    A few important specifications required to be considered are mentioned below:

    a) The quality of the breathing air supplied to the user must conform to BS:4274 British Standard and IS:10245 – 1982. Breathing air should not

contain more than 0.5 mg/m^3 of particulate matter, 500 ppm of carbon dioxide and 5 ppm of carbon monoxide.

b) Breathing resistance must be within specified limits.
c) Life and efficiency of the sorbent of canister/cartridge against the specific gas or vapours should be more or equal to the specified period under different test conditions.
d) valves leakage should not exceed the specified limits.
e) Face piece fitness test should conform to the requirements.
f) Filtration efficiency of the dust mask should be more than 98.5 % for the particles of the size of 0.4-0.6 µm .

11. The performance of the respirators are ascertained by subjecting it to the various tests in a simulated condition as per the specifications of BIS Such test facilities are available in Central Labour Institute, Mumbai, which are utilised by the manufacturers and user industries. Bureau of Indian Standard also sends samples to this laboratory for ascertaining the quality before certifying any respirator with ISI Marks.
12. Breathing apparatus should be safely kept in a separate bag or container to avoid contamination from the work place atmosphere.

Care and effective use of respirators

Respirators and breathing apparatus should be carefully maintained to retain their original efficiency. For this purpose, a few of the points are required to be taken into account, which are given below:

a) System for periodic inspection and maintenance with recording.
b) Inspection, maintenance and recording every time after use.
c) Cleaning and disinfecting as recommended by the manufacturers.
d) If possible, respirators may be issued to individuals.
e) The filters of the dust respirators are required to be cleaned or replaced, if pores are clogged.
f) Users must be trained before they are asked to respirators.
g) Periodic drills for the use of breathing apparatus may be arranged.

Personal Protective Equipment – Non Respiratory

Non-respiratory Personal Protective Equipment for various parts of the body can be divided into five broad groups.

1. Head Protection.
2. Ear & Eye Protection.
3. Hand & Arm Protection.
4. Body Protection.
5. Foot & Leg Protection.

1. Head Protection

Safety Helmet is one of the most important type of Personal Protective Equipment and widely used by the workers for protection against head injuries, which may be caused by falling /striking objects in industries like mining, tunneling, ship building, construction and engineering. A blow to the head is the most common cause of all head injuries in the work place. Sharp, heavy objects can penetrate & break open the skull causing deep cuts, fractures or brain injury. Safety helmets act as a barrier against such hazards and it can also protect the head from flame, preventing burn injuries. Safety Helmet used for protection of head deflects object and distributes the force of the impact over the whole head, diffusing the gravity of the blow. A permanent extension of the shell over the eyes protects the face, and especially eyes from injury. The brim is a narrow rim surrounding the shell also helps to deflect objects away from the head. The chin strap holds the helmet securely in place. Ventilation holes in the shell allow circulation of air inside. Safety helmet should be of right size, to fit correctly and comfortably .

Safety helmets are one of the most frequently used forms of PPE. Safety Helmets will protect the user's head against:

- impact from objects falling from above, by resisting and deflecting blows to the head.
- hitting fixed dangerous objects at the workplace,
- lateral forces - this would depend on the type of hard hat selected. Traditional hard hats are not designed to protect users from impacts to the front, side or back of the head.
- open flame, molten metals splash, electric shock, high temperature – this would depend on the standard of the hard hat selected for example a standard hard hat will not protect against an electric shock.

In general, protective helmets, or hard hats, should:

- Resist penetration by objects,
- Absorb the shock of a blow,
- Be water resistant and slow burning, and
- Come with instructions explaining proper adjustment and replacement of the suspension and headband.

All employees working in areas where there is a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock and burns, shall be protected by protective helmets. Safety helmets must be worn when performing most construction works, works in the vicinity of lifting equipment (cranes, hoists, etc.) and suspended loads, works in forestry, works in cisterns, wells, shafts, tunnels, etc. In these situations the use of a safety helmet will help protect against injuries to the scalp, skull and cervical vertebrae.

It is the responsibility of the employer to conduct a risk assessment and determine the need for head protection at the workplace.

For Electrical jobs, suitable safety helmets shall be used to withstand high voltages. Further, helmets are classified into :

Class A – Limited voltage for general services

Class B – High voltage resistance

Class C – No voltage protection

Class D- Limited protection for fire fighting

In some situations the safety helmets serves as a base for other kinds of PPE i.e .will be used together with other PPE, e.g. hearing protection, face visors or respiratory protection equipment. In these situations it is important that the suitability and the compatibility of the different PPE are considered.

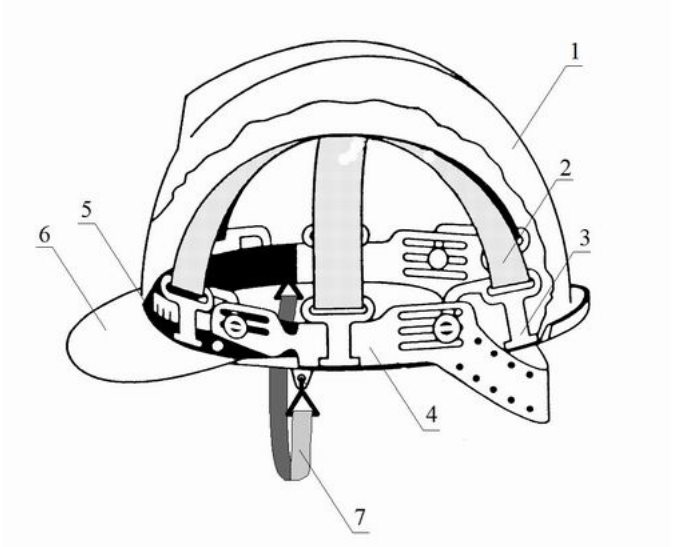


Figure 1: Construction of an industrial safety helmet. 1 – shell, 2 – harness, 3 – harness fixing, 4 – headband, 5 – sweatband, 6 – peak, 7 – chinstrap.

All Safety helmets should come with instructions on how to correctly adjust and adapt the helmet for each individual user's needs. It is therefore important that before using the safety helmet, the user should read and become familiar with these safety instructions.

When adjusting and positioning a safety helmet on the head, the user must ensure that the:

- harness straps crossing the top of the helmet adhere closely to the head,
- headband which runs around the head strictly adhere to the forehead and nape of the neck,
- safety helmet is securely mounted on the head i.e. the helmet must be positioned on the head and should be limited by the minimum amount of clearance between the hard shell and the skull. This will give a low center of gravity and provide exceptional balance.
- helmet should be adjusted in a manner that even without the use of a chin strap it will stay on the head without falling.

The hard shell of the safety helmet is designed to protect the head against impact.

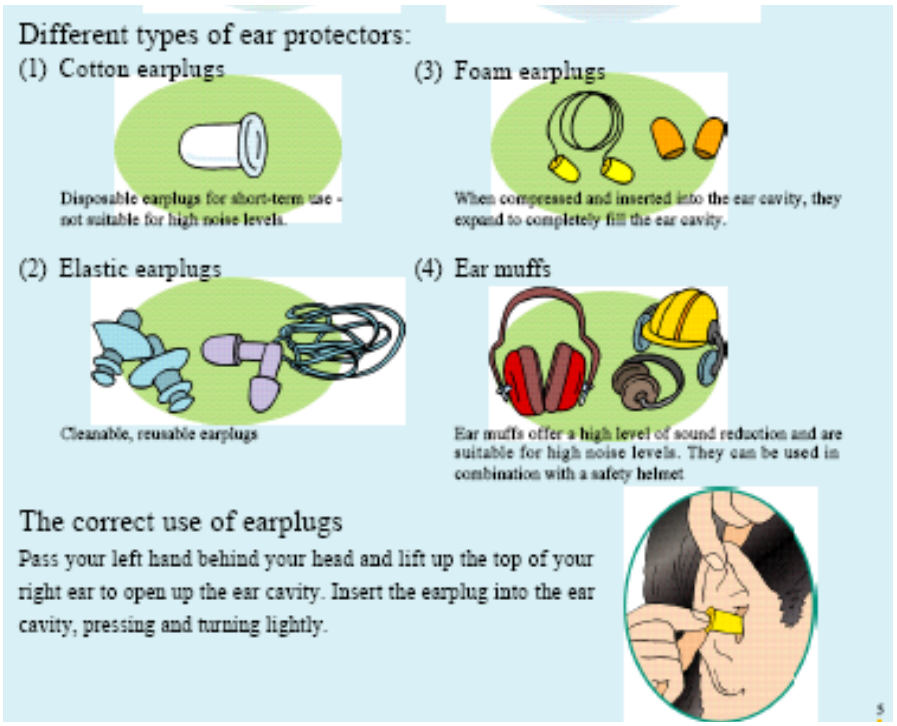
The specification for Industrial safety helmets, as given in IS : 2925-1984 .

Safety helmets require proper maintenance. You must not :

2. Ear Protection:

(a) Ear Protection : Hearing is one of life's most precious gifts. Exposure to loud noise can cause hearing loss. Such a loss is temporary and it is restored after a period of rest away from the noise source. Permanent hearing loss usually is the gradual decrease in hearing sensitivity over a period of time. Working under prolonged exposure to higher levels of noise can lead to hearing loss. High level of noise can also create stress that can sometimes affect one's physical and mental well being & cause accidents in the work place when people cannot hear instructions and warning signals.

There are three basic types of ear protectors namely Ear plugs, Canal caps, and Earmuff. Ear muff and ear plugs are tested as per IS: 6229-1980 & IS:9167-1979. It is believed that a properly carried out audiometric testing program will determine whether the hearing employees are in fact protecting their hearing system from noise. An audiometric testing programme should be maintained for workers who are exposed t o noise levels in excess of 90dB.



(b) EYE & FACE PROTECTION :

The most typical eye protection against external factors (e.g. radiation, dusts and droplets), is a natural protective mechanism of a human eye. The thin layer of slightly oily lachrymal fluid produced by the conjunctiva protects the human eye against pollution and infections. However, this natural protection is often insufficient in both everyday life and work environment. If you are exposed to dust, acids, molten metals, grinding wheels, hazardous optical radiation – you need to take the proper precautions and protect your eyes. Thousands of eye injuries occur in the workplace each year, warranting the need for total eye protection. Wearing the eye protection that your job or location requires is a simple way to keep your eyes safe. In general, of the eye injuries approximately 95 % were caused by particles or chemicals.

Wearing right type of eye protection on the job is the key to the prevention of eye injury at work. Selection of proper eye protector according to the type of hazard is very much important. If grinding, chipping and cutting operations are involved, there is a great risk of flying particles and dust, leading to eye injury.

Types of PPE provide Eye Protection	Types of PPE provide Eye & Face Protection
Safety Goggles – Used for protecting splashes 	Eye shield 

Safety Spectacles – Used for moderate impact such as Carpentry, wood working, Scaling. 	Face shield 
Eye wash showers 	Welding Shields - Protect eyes from burns caused by infrared or intense radiant light, and protect face and eyes from flying sparks, metal spatter, and slag chips produced during welding, brazing, soldering, and cutting. 

Industrial Safety spectacles with side shields are used for eye protection. Box cup goggles also provide protection against these hazards. Chemical splash goggles are used while handling chemicals. Welding goggles or optical filters should be used against radiation hazards. Welder's face shields protect the user against harmful optical radiation and other specific hazards arising during welding and/or related techniques. Welder's face shields include: face screens, hand screens, goggles, spectacles and hoods.

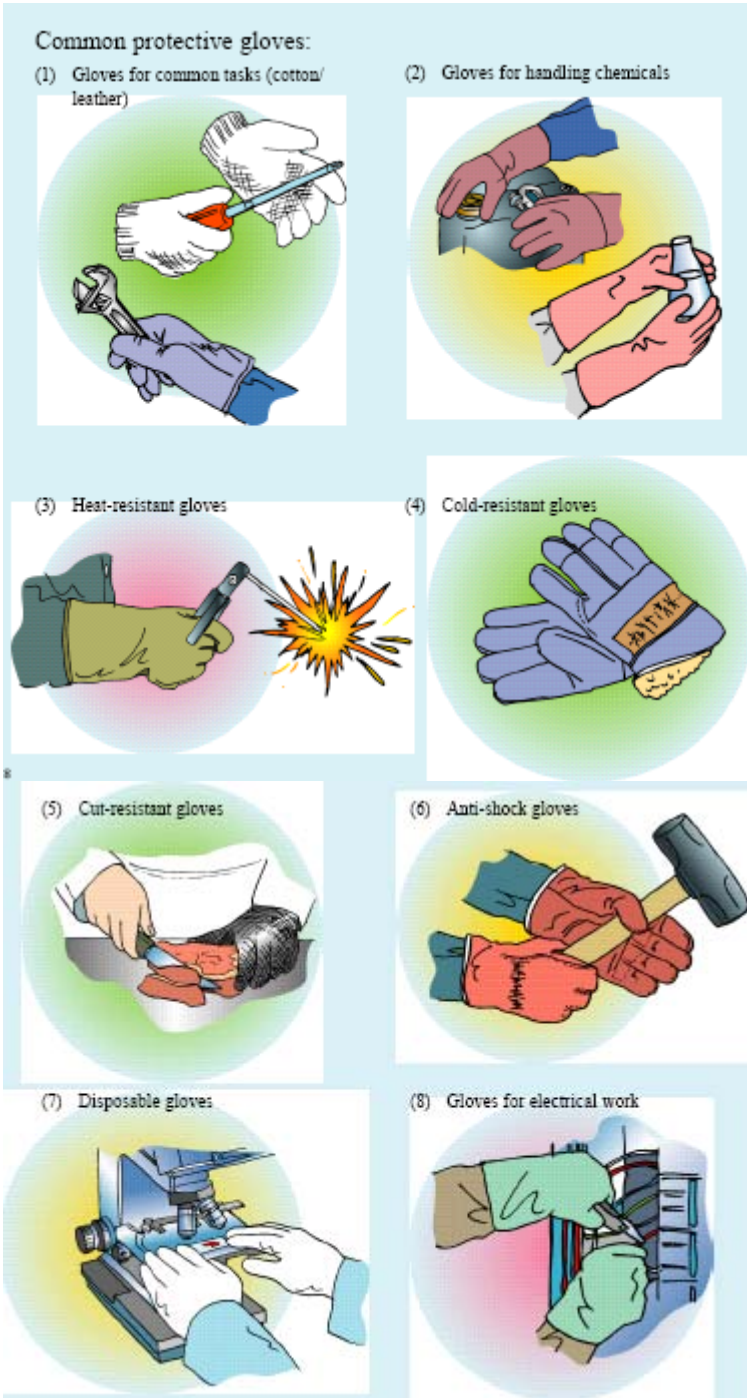
Improper use of eye protectors can lead to eye injury or eye fatigue and there is also a chance of accident. To ensure quality of eye protectors, its samples are tested as per BIS specification IS:5980 –1984 / IS: 7524 – 1980 Part-I/ Part-II for stability . Important tests are spherical and cylindrical power test and transmittance test for specific radiation for which they are used. In case of chemical goggles, chemical splash test is carried out to check resistance against splashes . Face shields are tested as per IS : 8521-1977 and IS 8521-1994 for impact test, robustness test, transmittance test and flammability.

3. Hand & Arm Protection :

Protection of hands and arms becomes necessary when workers have to handle materials having sharp end, sharp edges or hot and molten metals, chemicals and corrosive substances. Whenever machinery is in use, hands are at risk from mechanical hazard. Safety hand gloves will give protection from lacerations, amputation with punctured flesh and bone leading to serious infection. They also protect from destruction of tissue, severe burns, frost bite leading to loss of fingers and toes. Contact with irritating substances can lead to inflammation of the skin and dermatitis caused by chemical and biological agents. Safety hand gloves are made of leather, canvas, PVC coated fabric, Rubber etc. They are tested against IS: 2573-1986, IS:6994-1973, IS: 4770-1991 & 4501-1981 for chrome content, tongue tear test, braking strength, tensile strength, elongation at break and resistance to chemical etc.

Electric line repairs working around energized high voltage should use specially made and tested rubber gloves as per the Indian standards (IS : 4770-1991). Synthetic rubber such as Neoprene gloves should be used for handling derivatives of petroleum . PVC gloves are synthetic thermoplastic polymer provides excellent wet grip and abrasion resistance. It is chemically resistant to oil, grease , acids and solvents.

Where a complete glove is not necessary, finger stalls may be used. These are available in combination of one or more fingers. Finger stalls can be made of asbestos , rubber , leather , metal, mesh etc.



When selecting protective gloves, the choice should be based on the work, the wearer and the environment he or she works in. The following five factors need to be considered:

1. Identify the substance handled

It is important that the substance being handled is known since the level of protection and the type of glove needed will depend on this.

2. Identify all other hazards for hands

Identify any other hazards present. For example, is there a risk of abrasion, cuts, puncture or high temperatures?

3. Consider the type and duration of contact

- Will gloves be worn for a short time, intermittently or for long periods? Comfort is more important for longer wear. Generally, thicker, robust gloves offer greater protection than thinner gloves but thinner gloves offer better dexterity.
- Will contact be from occasional splashes or by total immersion? Short gloves are fine as protection against splashes. If the hands are immersed (and you can justify that this is unavoidable), choose a length greater than the depth of immersion.

4. Consider the user – size and comfort

- Gloves should fit the wearer. Tight gloves can make hands feel tired and lose their grip. Gloves that are too big can cause creasing; these can impair work and be uncomfortable. It can help to use sizing charts.
- Comfortable gloves are more likely to be worn. Involve employees in the selection process and give them a reasonable choice to pick from.
- Hands can sweat inside gloves, making them uncomfortable to wear. Getting staff to take glove breaks, removing gloves for a minute or so before hands get too hot and sweaty, can help to air the hands. You could also consider supplying separate cotton gloves to wear under protective gloves. These can improve comfort by absorbing sweat. They can be laundered and reused.

5. Consider the task

- Gloves should not hamper the task. If wet/oily objects are handled, choose gloves with a roughened/textured surface for a good grip. Select gloves that balance protection with dexterity. Ensure the gloves selected meet all standards required for the task, e.g. sterile gloves, food-grade gloves. Consider whether colour is important, e.g. to show up contamination.

Once the appropriate gloves for the task have been selected, employees must be trained and informed on how to use the gloves properly so as to protect themselves. The information provided should include when they should be replaced and, if they are reusable, how to rinse them before removal (if practicable) and how they should be stored.

4. Body Protection

In hazardous work environment the skin is the most vulnerable part of our body to get physical injury and infection from harmful exposures. The skin has two layers. The epidermis or the outer layer which constantly sheds dead cells and replaces them with new ones. The dermis, the inner layer which contains sweat glands, nerves endings, oil etc. The skin acts as a barrier against harm from sunlight, bacteria and physical injury. However, the protective skin of human body cannot withstand the penetration of harmful chemicals and solvents. A number of chemicals are absorbed through the cutaneous root without one being aware of it. The harmful effect of this can be severe and long term effects are often irreversible. Body protection may be required against the following main types of hazards:

- Hot metals
- Impact and cuts
- Exposure to toxic materials

Protection against Heat and Hot metal :

- **Leather Clothing :** It provides protection against heat , splashes of hot metal, Infrared and ultraviolet radiations.
- **Asbestos & Wool Clothing :** Special treated asbestos clothing has been developed which is impervious to metal splash upto 1600 deg C. This type of PPE is required by foundry men working with molten metal.
- **Aluminised Clothing** : For operations involving temperature upto 1100 deg C , use of aluminized clothing is essential, as seen in furnaces & ovens, coking, slagging, fire fighting and rescue work.

Protection against Impact and cuts :

Aprons of padded leather. Plastic, hard fibre should be used. Padded ducks should be used by workers who carry heavy loads or objects with rough edges.

Protection against Chemicals :

Where chemical exposure cannot be prevented by other means, individual protection measures including PPE needs to be applied. Chemical protective clothing (CPC) should be selected to reduce the hazardous exposure well below the danger level. The aim is that the exposure is not at the statutory occupational exposure level, but at a level which the employer can trust to be safe for the employee. The first choice to be made is the clothing type. The types are categorized in accordance to the leak tightness and the structure of the clothing . Second, the resistance to permeation or penetration by chemicals has to be considered. The clothing also needs to be of adequate mechanical strength to suit to the task to be carried out. Maintenance and user comfort must not to be overlooked. Many CPC materials catch fire easily. If this risk is present, the CPC needs to be selected accordingly. If the risk posed by the chemicals used concerns only a part of the body, the CPC can be selected to protect only that part of the body, e.g. arms. Clothing made of impervious materials should be used by workers for protection against dust, moisture and corrosive liquids. Materials used for this type of protection include natural rubber, synthetic rubber, neoprene, vinyl, polypropylene, polyethylene films and fabrics coated with them.

(1) General purpose protective clothing
Including raincoats

(2) Heat-resistant work clothing/aprons
Used for welding to prevent burns from sparks, fragments and flying molten metals

(3) High-temperature work clothing
For employees working around smelting furnaces, firemen etc.

(4) Low-temperature work clothing
For employees working for long periods in refrigerated conditions

(5) Anti-electrostatic work clothing
Suitable for workplaces where flammable materials are handled or where static charges might affect the quality of electronic products

6) Impermeable work clothing for protection against chemicals
Chemical spill handling and asbestos handling etc.

(8) Reflective clothing
Such as for working in busy traffic; brightly-coloured reflective clothing can increase the visibility of employees and reduce their chances of being struck by vehicles or machinery

(7) Life jackets
Reduce the risk of drowning when an employee falls into water

(9) Work clothing to prevent cuts
Suitable for employees operating sharp blades and machines

5. Foot and Leg Protection :

Adequate protection may have to be provided to the workers employed in certain jobs where there may be risk of feet injury may be in handling of heavy materials, exposure to caustic and corrosive liquid, oils and grease, molten metals etc. Common foot and leg protective equipment are safety shoes and boots, leggings, foot guards and leg guards. In general, the footwear worn in the workplace should be chosen to avoid recognized types of injuries such as:

- contact with falling, rolling or cutting objects,
- penetration through soles or uppers (stepping on sharp and pointed elements),
- anti-static and electrical hazards,
- contact with chemicals and biological agents,
- exposure to thermal factors (cold and heat) as well as molten metals,
- wet and slippery surfaces.

Foot and leg protection choices include the following:

- Leggings protect the lower legs and feet from heat hazards such as molten metal or welding sparks. Safety snaps allow leggings to be removed quickly.
- Metatarsal guards protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes.
- Toe guards fit over the toes of regular shoes to protect the toes from impact and compression hazards.
- They may be made of steel, aluminum or plastic.
- Combination foot and shin guards protect the lower legs and feet, and may be used in combination with toe guards when greater protection is needed.
- Safety shoes have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres or nonconductive to protect workers from workplace electrical hazards.

Special Purpose

Shoes Electrically conductive shoes provide protection against the buildup of static electricity. Employees working in explosive and hazardous locations such as explosives manufacturing facilities or grain elevators must wear conductive shoes to reduce the risk of static electricity buildup on the body that could produce a spark and cause an explosion or fire. Foot powder should not be used in conjunction with protective conductive footwear because it provides insulation, reducing the conductive ability of the shoes. Silk, wool and nylon socks can produce static electricity and should not be worn with conductive footwear. Conductive shoes must be removed when the task requiring their use is completed. Note: Employees exposed to electrical hazards must never wear conductive shoes.

Electrical hazard, safety-toe shoes are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground. These shoes can protect against open circuits of up to 600 volts in dry conditions and should be used in conjunction with other insulating equipment and additional precautions to reduce the risk of a worker becoming a path for hazardous electrical energy. The insulating protection of electrical hazard, safety-toe shoes may be compromised if the shoes become wet, the soles are worn through, metal particles become embedded in the sole or heel, or workers touch conductive, grounded items. Note: Nonconductive footwear must not be used in explosive or hazardous locations.

Foundry Shoes : In addition to insulating the feet from the extreme heat of molten metal, foundry shoes keep hot metal from lodging in shoe eyelets, tongues or other shoe parts. These snug-fitting leather or leather-substitute shoes have leather or rubber soles and rubber heels. All foundry shoes must have built-in safety toes.

Care of Protective Footwear : As with all protective equipment, safety footwear should be inspected prior to each use. Shoes and leggings should be checked for wear and tear at reasonable intervals. This includes looking for cracks or holes, separation of materials, broken buckles or laces. The soles of shoes should be checked for pieces of metal or other embedded items that could present electrical or tripping hazards. Employees should follow the manufacturers' recommendations for cleaning and maintenance of protective footwear.

Some of the Indian standards relevant for foot protection is listed below :

PVC Gum Boots – IS :12254-1988

Fireman's Leather Boots – IS : 4128-1980

Leather Safety Boots and Shoes – IS:1989-1986

This is a combination of safety boots and leg guards; gives full protection to welders.

Aluminised Safety Boot, Asbestos Safety Boot, Gum Boot, Leg Guard, Leather Safety Boot.

CARE & EFFECTIVE USE OF NONRESPIRATORY PERSONAL PROTECTIVE EQUIPMENT :

Personal Protective Equipment should always be carefully inspected, repaired and maintained in its original condition. For this purpose, following points must be kept in mind.

- Proper maintenance of safety helmet is required to be done by regular checking for cracks, dents and for broken straps. The sweatbands and cradle of the safety helmet should be washed with warm, soapy water or suitable detergent solution.
- Goggles must be frequently inspected while in service. See that damage parts, lenses, etc. are replaced before they cause any discomfort or result in loss of protection.
- Goggles should be kept clean and sure that they are sterilized frequently. Lenses should be wiped carefully with a clean, soft cloth.
- Goggles should always be kept in a substantially clean case or box to prevent scratching. It should not be thrown carelessly into boxes or on to the bench. Never carry goggles loose in the pocket.
- Provision of a comfortable Safety shoe. A good fitting will not cramp or chafe the feet on the job. Keep shoes as dry as possible.
- Do not allow shoes to get deteriorated beyond repairable condition, whether the repair is undertaken by the employee or employer.
- Replace worn out sole before it gets further damaged
- For protection against acids, caustics, solvents and similar materials, fabrics impregnated or coated with plastics are used for garments.
- Use warm soapy water for cleaning chemical resistant clothing & gloves.
- Protect rubber equipment from excessive heat and mechanical damage.

The Requirement for PPE : To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment. In general, employers are responsible for:

- Performing a "hazard assessment" of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program.

In general, employees should:

- Properly wear PPE,
- Attend training sessions on PPE,
- Care for, clean and maintain PPE, and
- Inform a supervisor of the need to repair or replace PPE.

Always wear PPE according to the Signage mentioned in that working area .

Safety while working at Height :

Falls are the biggest cause of deaths in workplaces throughout the world. All over the Industry, construction sector registers highest rate of accidents - nearly 80 % due falls of people and about 20% due to fall of objects on people. On top of this, high percentages suffer major injuries such as broken bones or fractured skulls.

Risk faced due to working at high elevation or the problem of fall can be even avoided by planning an alternative strategy. This is, of course, the best-case scenario, but oftentimes, the best-case scenario is impractical for a number of reasons.

If working at height cannot be avoided, the next step is to make use of the wide work equipment available to prevent falls occurring in the first place. For every job, there is a gear and its features are designed to meet specific challenges posed by working conditions.

About Height Safety Gears (The Height Safety Alphabet) a, b, c, d, e, f, g & h of Fall Protection

- **A-** Anchorage points
- **B-** Body harness
- **C-** Connectors
- **D-** Decenders and controlled lowering devices
- **E-** Emergency Rescue and response devices
- **F-** Fall Arrest systems
- **G-** Guard Rails
- **H-** Horizontal Work lifelines

SAFETY IN MATERIAL HANDLING

Material is handled between operations in every department, division, or plant of a work area. It is a job that almost every worker in industry to handle - either as his sole duty or as part of his regular work, either by hand or with mechanical help

Handling of material accounts for 20 to 25 percent of all occupational injuries - These occur in every part of an operation, not just the stock room or warehouse. Strains, sprains, fractures, and contusions are the common injuries. They are caused, primarily by unsafe work practices, such as improper lifting, carrying too heavy a load, incorrect gripping, failing to observer proper foot or hand clearances and failing to wear personal protective equipment.

Safety in Manual Handling :

Main steps in manual handling :

To gain insight into the material handling injury problem, the safety professional should consider the following operating practices and management policies.

1. Can the job be engineered to eliminate manual handling so far as possible?
2. Can the material be conveyed or moved mechanically?
3. In what way do the materials being handled (such as chemicals, dusts, rough and sharp objects) cause injury?
4. Can employee be given handling aids, such as properly sized boxes, adequate trucks, or hooks that will make their jobs safer?
5. Will protective clothing or other personal equipment help prevent injuries?

The person handling the material is safe when-

- He plans the move
- He knows the right way to lift
- He knows how to carry objects
- He knows how to set them down
- He knows the proper way to push and pull

Techniques of lifting loads

1. Correct position of feet
2. Straight back and bent knees.
3. Load held close to the body for lifting and carrying.
4. Correct grip
5. Chin in
6. Use body weight

Do manual lifting or lowering of a heavy load in front of the body, with the back kept straight and with stable feet positions , and use the power of the legs.

A long heavy object can be lifted using the power of the legs by keeping the object as close to the body as possible.

Handling grips adapted to the particular object carried can help.

Lifting of heavy loads from a platform in front of the body while using the power of the legs. Lifting from a platform is better than lifting from the floor.

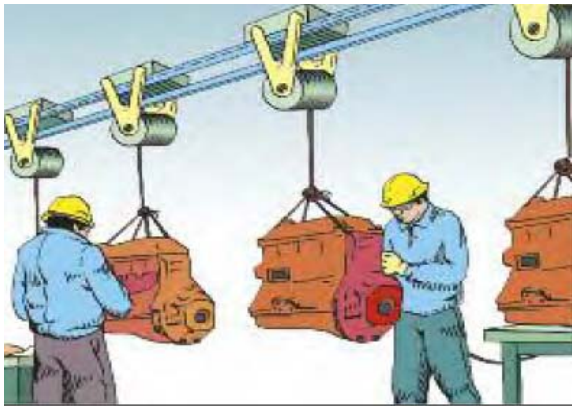
MECHANICAL MATERIAL HANDLING

LIFTING TACKLES

- Do not exceed safe working load at any point of time.
- Avoid crossing, twisting, knotting of a wire rope/chain sling.
- Lift load smoothly, avoid jerks, impact and swings.

General :

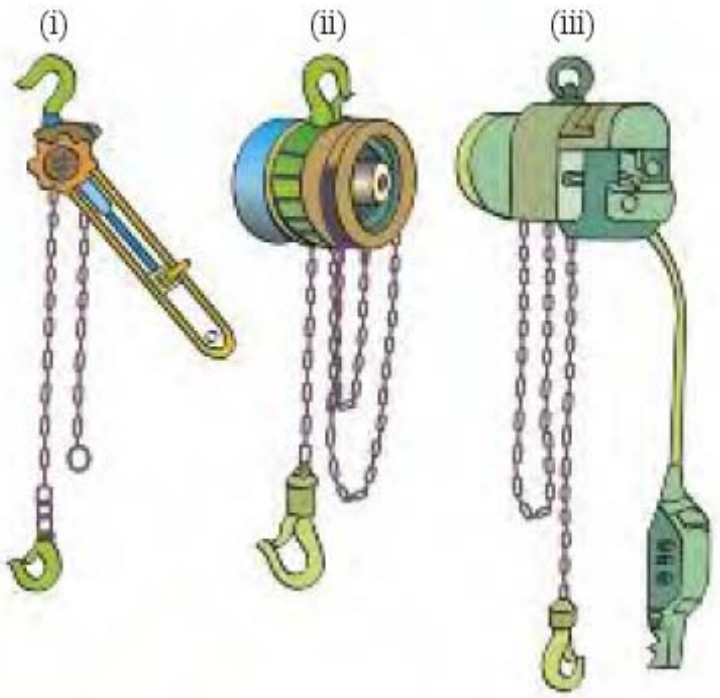
- Check brakes, lifting mechanism, limit switches, controls, guards, wire rope, hook, blocks etc. of EHB, EOT cranes.
- Check brakes, lifting mechanism controls, guards, tyres etc. of forklifts.
- Never drive crane or a vehicle with wet or greasy hands.
- Always drive vehicle at safe speed, slow down when taking turns, and blow horn at corners.
- When driving without load keep forks minimum 15 cm above ground.
- Avoid sudden starts and stops.
- Avoid carrying oil drums, gas cylinders on forklift boom.
- Do not cross over conveyors and roller table.



Mechanical transport of materials can both to eliminate manual work and improve work height and working postures.

We shall examine the main mechanical handling equipments like

1. Hand operated chain pulley block
2. Electric Hoist Block
3. Crane



1) A lever hoist is simple to operate & extremely versatile.
2) A chain hoist with a self activating load brake.
3) An electric chain hoist with butterfly control switch for efficient handling of lighter loads.

CARE & SAFE USE AND INSPECTION CHECKS:

1) HAND OPERATED CHAIN PULLEY BLOCK:

- Never lift a load in excess of safe working load marked on the block.
- Twisting of load chain should be avoided in single fall or multiple fall.
- Load to be applied centrally.
- No direct binding of load with load chain, i.e. never use load chain as a sling.
- No extreme slant slinging.
- No over lifting, No over lowering, No rough handling.
- Don't forget to oil the load chain after use, do not use grease for lubricating load chain.
- If Load chain jumps, does not work smoothly or marks in use, it is probably out of pitch & should be replaced.
- Do not allow dirt and hard grease to gather in pockets of the load or hand chain.
- Do not store or leave the pulley blocks lying on the ground where they can collect dirt.
- Care shall be taken when replacing the chains that same Grade and size of chain is fitted; Grade of chain is marked on pulley blocks by manufacturer.
- Gears should be periodically greased. (HPC lithon-2 is recommended)

- Never weld the load chain.
- Hook should be used with safety latch.
- Hook should be periodically examined for opening, i.e. for elongation.
- Never lift load from hook corner.
- Examine the hook for swivel movement, that is top hook under no load and bottom hook with load should be possible to rotate.
- Brake system is through Ratchet and Pawl mechanism, hence never remove pawl.
- Friction washers should not be lubricated. They are made of brake lining material.
- Operator should always wear helmet during operation and no person should stand under lifted load.
- Operator should warn persons around to avoid any accidents.
- Care should taken that lifted load should not swing during operation.
- Handling to be done carefully while block is operated above furnaces or on any heating equipment..
- It is always recommended to use Pulley Block as per class Designed.
- Pulley Block should be examined, inspected & tested by an impartial & competent authority once in a year for its wear and safe working as certified in Factories Act 1948.

Routine examination

The chain pulley block should be regularly inspected for damage and wear and to ensure that it is operating smoothly. Where the hoist is used infrequently, a visual check should be made of the chain pulley block each time it is used.
Where a chain pulley block is used or stored outdoors or in corrosive or abrasive conditions, inspection and lubrication must be attended to more frequently.

2) ELECTRIC WIRE ROPE HOIST

- Never lift a load in excess of the safe working load marked on Hoist.
- Always lift load vertically.
- Never lift with the point of hook.
- Never run the wire rope out too far.
- Apply grease to the wire rope periodically.
- Before use of hoist, examine the wire rope to ensure that there is no twist.
- Do not lubricate any point of contactors.
- Inspect the wire rope for wear and tear regularly.
- Under no circumstances should the hoist be operated when Limit Switch is not operating properly.
- Ensure that the rope drum is perfectly horizontal when Hoist is used as a fixed suspension unit.
- Examine the supply provided and connections are made accordingly.
- Examine brake operation periodically and set the brake adjustment.
- Periodically examine the bolts and nuts. If required tighten them.

- Load should not be allowed to swing during operation.
- Operator should use helmet.
- Never open any electrical contact when supply is ON.
- Hoist should be examined, inspected & tested by an impartial & competent authority once in a year for its wear and safe working as certified as Factories Act 1948.
- Always use lubricant for gears as recommended by Hoist Manufacturer.
- Periodically examine that no foreign particles accumulate on Beam on which Trolley is moving.
- Care should taken that Electric hoist block fitted on Beam should be properly ground if it welded.
- Do not leave load suspended in the air for long time.
- It is always recommended to use Hoist as per class Designed.
- Electrical parts shall be protected, if application is out door.

3) CRANE

Various types of cranes are:-

- Hand operated traveling crane (HOT)
- Electric overhead Traveling crane (EOT)

Safety Measures :

- Never lift a load in excess of the safe working load marked on crane
- Always lift load vertically.
- Never lift with the point of hook.
- Never run the wire rope out too far.
- Apply grease to the wire rope periodically.
- Before use of crane, examine the wire rope to ensure that there is no twist.
- Do not lubricate any point of contactors.
- Inspect the wire rope for wear and tear regularly.
- Under no circumstances should the crane be operated when Limit Switch is not operating properly.
- Examine the supply provided and that connections are made properly.
- Examine brake operation periodically and set the brake adjustment.
- Periodically examine the bolts and nuts, if required tighten it.
- Load should not be swing during operation.
- Operator/helpers should use helmets.
- Never open any electrical contact when supply is ON.
- Crane should be examined, inspected & tested by an impartial & competent authority once in a year for its wear and safe working as certified as Factories Act 1948.
- Always use lubricant as recommended by crane Manufacture.

- Periodically examine that no foreign particles are accumulated on crane movement path, i.e. on beam.
- Do not leave load suspended in the air for long time.
- It is always recommended to use crane as per class designed.
- Lock the movement of crane when it is not in use.
- Switch off the power supply when crane is idle.
- Periodically verify the supply wire conditions.