

Stores Management System Manual

PART – II

Guidelines on Material Preservation, Material Handling, Safe Operations and Construction of Stores Houses and Open Yards

Andhra Pradesh Power Generation Corporation

(A Government of Andhra Pradesh Undertaking)

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Andhra Pradesh.

CHAPTER-1 PRESERVATION OF MATERIALS

1. Preservation of Materials

Many of the items, especially insurance spares may be required to be kept in stores for many years. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, lose some of their properties and become unusable due to atmospheric conditions and biological elements. Economical utilization and conservation of resources and available materials, stores or equipment are of paramount importance for the progress of the organization.

Since a large number and range of items shall be stored at Corporation's power stations, it may not be possible to lay down procedure of preservation of individual items. Attempts have, however been made to cover procedure for certain important categories of materials. These are general methods of preservation and any specific instruction from manufacturers for preservation shall additionally be followed.

Proper preservation shall be ensured by storekeeper/custodian who shall work under guidance of user departments. User departments shall also extend full cooperation in this regards and visit stores from time to time to assess implementation and advise in the matter.

1.1. Factors influencing deterioration:

The stores/equipment are made of particular materials with specific characteristics. With passage of time and sometime due unfavourable storage conditions, those characteristics of qualities tend to change or deviate from their properties and making them sometime unfit for use. This change in characteristics of stores is referred to as deterioration. Due to deterioration, materials or stores manufactured therefrom, may not be able to fulfill intended functions. Provision of proper storage conditions for items, treating them with preservatives and packing them properly reduces considerably the rate of deterioration. The agencies, which cause deterioration, may broadly be classified a) Biological and b) Non-biological.

1.2. Damages due to biological process:

Damages are caused to stores by organism such as white ant, mildew, rat etc. These are living organism and this type of damages is usually referred as biological damages. Items like wooden poles, bamboo, furniture, stationery, textiles, leather goods, timber, food grains etc. are prone to loss by these agents of deterioration.

1.2.1 Preventive measures:

Preventive measures consist essentially either creating a barrier between causes of deterioration and the article by using a chemical in the stores house, where such materials are stored. The treatment generally carried out (a) Immersion of bamboo and wood poles in a mixture of creosote and mustard oil for a period of at least twelve hours. Linseed oil may be used when timber stores are to be treated. (b) Injection of some oil mixture like creosote and mustard oil in to hollow of timbers followed by swabbing of the entire outer surface. c) Painting and washing of timber stores.

(a) White Ants

The termites are white -ants, as they are commonly known, are insects that attack and destroy anything that is of plant origin such as bamboo, timber etc. The food of the termite is anything, which is of vegetable origin. But it does, however, even destroy woolen stores.

White Ant is usually very active during the monsoon and prefers moist soil and may attack stores in contact with walls or roof or ground. The presence of white ants is noticeable by mud adhering to damage portion of stores.

Preventives:

No curative measure is known in the case of white ants and all treatments are preventive and protective in nature. They may be summarized as under:

- (i) Stores should be kept up the ground at least 12” high or on dunnage made out of metal or any materials not susceptible to white ant damage.
- (ii) The floor of godown and storehouse should be made of concrete. All cracks should be repaired promptly
- (iii) Stores should not be allowed to touch the roof or walls. Timber should be treated with oil mixture such as creosote up to a height of 2 feet from the ground.

(b) Rot and Mildew

Rot and mildew are names given to organism belonging to the plant kingdom, which is also the cause of considerable damages to stores. Mildew can be defined as the low form of a plant known as Fungi. The rot may, in general be defined as the state of deterioration of stores caused by microorganism called bacteria. Both of them attack easily all stores, which are of plant origin i.e. contains cellulose of some form or other. Rot and Mildew generally take place during monsoon and in places, which are damp and wet.

Symptoms of Mildew damage are:

- (i) The presence of musty smell in items of vegetable origin and ammoniac smell in animal products.
- (ii) Decolourization of stores.

Preventive Measures

Following are the preventive measures which help in minimize the damages by rot and mildew

All godown and storehouses must be opened daily to allow free ventilation particularly during the monsoon season.

- (i) Stores must of kept on dunnage, away from walls and off the ground. They must not touch the roof.
- (ii) In case of temporary shelters, the attached covers must be folded and the ends must be tagged off the ground. Bales of cloth or gunny bags must be kept at some distance from each other.
- (iii) Stores should not be packed and stacked while wet or damp.
- (iv) Stocks should be frequently turned over.
- (v) Stores must be inspected frequently and should be immediately treated when any damage is noticed.

Curative Measures

There are a few curative measures, which are of general application. Some proved more useful and are mentioned below:

- (i) Damaged stores should be exposed to the sun for few days with a frequent turnover.
- (ii) An insecticide may be used or sprayed on the damaged portion.
- (iii) Oils and chemicals used to kill insect pests are effective against rot and mildew also.

Before any treatment is given, the damaged stores should be segregated from the uninfected one.

(c) Rats

- (i) Rats and mice damage stores either by feeding on them, utilizing them as nesting materials or for sharpening their teeth. All stores except those made from metal, stone, porcelain and glass are liable to be damaged. Rats also act as carriers of some diseases.
- (ii) Rat is extremely suspicious creature. It has well-developed sense organs and very intelligent in behavior. Due to all these characteristics, there is generally a problem of rat control. Measures to be taken for preventive damages by rats are: Rat Proofing, and Rat Destruction

Rat Proofing:

Prevention is better than cure. If proper precautions are taken from the very beginning of storage, one can protect stores to the maximum extent. This can be done by rat proofing of godown and keeping the stores, prone to losses by rats, in rat proof containers. Rat proofing is done before keeping the goods in storehouses.

Rat Destruction

Rat destruction campaign is found to be more effective in indoor area. This shall be repeated at suitable intervals. Removal of bait shyness, washing of traps with running water and changing of bait are three main points to be considered. Disposal of catches is also important as live catches must be killed and disposed off by burning.

The poison baiting is another method of rat destruction.

Anticoagulant i.e. Tomorin, Rodafarin etc. can be dusted on rat runs and rats automatically get poisoned due to their licking habits.

The rats in storehouse can also be controlled with the help of cats and dogs.

As far as possible both methods should be used concurrently.

1.3. Damages due to non-biological causes:

Under this section is included various types of damages not caused by any living organism. Rusting of iron stores, corrosion, cracking of paints, hardening of rubber, cracking of timber and such like are common experiences and these are some of the most important types of non-biological damages to general stores.

1.3.1. Corrosion:

Corrosion relates to deterioration of metal surfaces due to reason other than mechanical ones and deliberate destruction of iron parts and even pitting of aluminum utensils are example of corrosion.

Corrosion is usually caused when one of more of following conditions prevail:

- (i) When materials are exposed to harmful gases in the industrial town.
- (ii) When materials are in continuous contact with water in the presence of air.
- (iii) When materials are exposed to solutions of acids, alkalis or salts.

1.3.2. Rust

Rust is compounding formed by the oxidation of iron in the presence of moisture. The term “Rust” is restricted to iron and steel only. While the term “Corrosion” is applicable to all metals.

1.3.2.1 Preservation:

Applying some preservatives to the metal surface, by making a barrier between the atmosphere and the metal, prevents corrosion damage to metals. Before a preservative is applied, the metal surface must be cleaned and free from grease. The surface should be de-rusted, if it is corroded and must be made completely dry.

1.3.2.2 Cleaning and degreasing

Washing with water, scrubbing with rags or rubbing with sand paper or emery cloth may carry out cleaning and degreasing. Cleaning and degreasing may also be done by chemical methods such as:

- (i) Dissolving the grease in chemicals such as carbon tetrachloride, kerosene oil or white spirit.
- (ii) Immersion of dirty and greasy articles in solution of caustic soda or soda ash.

However, before the above cleaning methods are employed, the rust and scales may first be removed by mechanical methods such as rubbing with emery cloth/paper or steel wire brush. Kerosene oil may be used as rust loosening.

After the store has been cleaned and rust free stores should be thoroughly dried by one of following methods before preservative coating is applied.

- Blow hot air.
- Blowing dry compressed air, and
- Wiping with clean rags

If none of the above methods are possible, it may be dried in the hot sun (if the weather is clear).

1.3.2.3 Preservative coating

Metals other than iron and steel do not normally require any protective coating. In case they are to be kept under corrosive conditions for long period, they should be given a protective coating of Mineral Jelly, Beeswax or grease and wrapped in grease resisting paper. Before a preservative method is to be adopted, it should be first ascertained if the protection to be given is for short term or long term. In case a short protection, the preservative can be easily removed and some cases do not interfere with the serviceability of the stores.

Some of these preservatives are mineral oils and greases and mineral jelly. In such cases, unless the value of the stores demands stringent controls, the cost of the preservatives is to be given due weightage. If the items are very huge, even waste oil (from garage) could be explored for use. After application of the preservative the stores should be wrapped in grease resisting paper or covered with tarpaulin. Some methods for long-term protection are:

a) Painting

Paints, lacquers, varnishes and enamels may be used to protect metallic surfaces against corrosion. On the clean surface there are two coats of a primer (red oxide/red lead) is applied. The primer is a rust inhibitor. Over the primer coat, an undercoat is applied which helps the primer coat remain dry and provide a satisfactory adhesion on the finishing paint.

In less corrosive, undercoat may be flopped, when there is severe lack of time and labour, even the elimination of finishing may be considered.

b) Volatile Corrosion Inhibitors (VCI)

There are volatile organic chemicals. Chemical, which give off, vapour possessing rust inhibitory properties. The vapour forms a very thin film over the metal surface. The VCI comes in the form of powder, solution and as coating on wrapping materials. The powder/solution may be sprayed on the materials or kept in a sustain bag/perforated container. The stores may otherwise be wrapped in the paper treated with VCI. It may be taken care that the materials treated with VCI should itself be kept in the enclosed space.

c) Desiccants:

Corrosion can be prevented by reducing the humidity to a level of 50% or less by use of drying agents, which are known as desiccants. The commonly used desiccants are silica gel, aluminum oxide and calcium chloride. The most suitable of the above is silica gel. The article to be protected with the above must be cleaned, dried and packed in airtight boxes to prevent the ingredients from outside moisture (caution: silica gel should never be applied on the article, but kept close to the stores). The silica gel needs activation when it absorbs moisture. This is done by heating it in an oven by placement with fresh silica gel.

d) Strippable Coating:

This type of coating is given by a special plastic formulation, which gives a plastic cover over the article, but can easily be peeled off when required for use. The peeled off coating can be melted and realized. This comes under the trade names as Glass Coat, Plastic Peel and Styropeel. This preservative is melted at 150 degree C to 200 degree C and the stores chipped and removed from it. The preservative leaves a thin tough plastic coat over the article.

1.3.3 Effect of Temperature:

Temperature may be extremely low, high, optimum for the growth of microorganism and insects or diurnal variation in temperature may take place.

Freezing results in bursting of container filled with aqueous materials due to expansion. Rubber, certain polymers and metal like molybdenum and zinc die-casting become

brittle at low temperature. A high temperature aging and chemical changes like oxidation become rapid and are particularly detrimental to rubber and certain drugs. High temperature may also impose strains on the containers. Diurnal changes in temperature may induce stress due to differential expansion and result in failure of stores where two or more materials are used. Diurnal changes in temperature may also result in dew formation and subsequent corrosion and fungus.

Dew formation results in failure of electrical/electronic equipment. In case optimum temperature prevails, damages due to microorganism or insect may take place.

1.3.4 Effect of Light

The effect of light alone or in presence of oxygen can be quite marked on chemicals, drugs, and photosensitive materials/polymers. They may form explosive peroxides or result in free radicals leading to actinic degradation

1.3.5. Effect of moisture

Loss of moisture may change the characteristics of the item and reduce its serviceability i.e. in leather goods, abrasive papers/clothes etc. increase in moisture may cause corrosion of metallic parts, may encourage biological/chemical deterioration or organic materials and may cause loss in insulation of electrical/electronic instruments/equipment.

1.3.6. Effect of Oxygen and ozone:

Oxygen and ozone cause oxidation and oxidation degradation in many compounds. These reactions are accelerated in presence of moisture and light.

1.3.7. Effect of environment generated by interaction:

a) Impact:

Packages are exposed to side and end impacts during handling and transit may cause damages to delicate parts of instruments i.e. pointers and suspensions and optical alignments etc. containers can be dented, glassware and others fragile materials may break, perishable may be crushed.

b) Vibration:

During its journey by road, rail, sea or air, the packages are subject to sustained vibration, which may result in failure of the equipment or instruments i.e. incandescent lamps element, weakening of container themselves i.e. wooden boxes.

c) Compression:

During storage or transit, packages are stacked as high as possible to utilize maximum possible vertical storage space. Packages at lower layers are subjected to compression under the load of upper packages. If the container is not strong enough, the compression is transmitted to the contents.

d) Tension, Tear etc:

Condition of tension, shear, torsion and tear result from the action of stresses on materials kept inside the container. Tension may be produced by suspending container from the top, shear and tear can be caused by the interaction of divergent stresses. Torsion and distortion do occur by exertion of stresses, which are not collinear, and not necessarily in a horizontal or vertical plane.

e) Gases and vapours:

These may be present in industrial /polluted atmosphere and inside storehouses because of presence of volatile substances. Increased amount of ozone may also be present in smog area. These may cause contamination and deterioration due to corrosion or other chemical reactions.

f) Chemical pollution:

Environments are greatly influenced by the nature of chemicals stored and handled and cause deterioration in other stores. Some chemicals are inactive and unstable, explosive or inflammable. Special storage precautions have to be taken for these.

g) Electromagnetic Radiation:

Electro-magnetism is an important phenomenon to consider whenever electrically operated equipment is used. Memories generated in modern sophisticated electronic equipment can be erased or distorted by those stray electromagnetic radiation. Barriers have to be provided for this radiation. Stray current produced in metallic parts of the stores may cause corrosion.

h) Static Electricity

It is caused by movement of electrons that occurs, when dissimilar substances in contact with each other are separated. If this is not neutralized or eliminated as rapidly as it is produced, it will eventually develop energy enough to jump as a spark to some nearby grounded or less highly charged object. The spark can ignite nearby combustible materials or vapours. While generation of static electricity cannot be prevented, its

dangerous accumulation can be prevented by conducting away the electric charges as fast as they are produced.

1.4 Storage Hygiene

1.4.1 Cleanliness:

All Stores rooms must be swept daily and cobwebs are removed. Cracks and crevices must be filled up. If possible saw dust shall be spread over the floor before sweeping. It stops spreading of dirt and dust in the air and subsequently accumulating on the storage racks and materials lying on them.

1.4.2. Ventilation

Air must be allowed to circulate freely throughout the storage area. The only exception is in respect of rubber articles where ventilation has to be restricted to a slow natural circulation of air. Free aeration helps in keeping the stores and stores rooms dry, and prevent accumulation of heat within the stocks, bundles and stores.

1.4.3. Segregation of infested stores:

Stores damaged by biological agencies should be segregated immediately the damage is noticed and given suitable treatment.

1.4.4 Disinfestation of Godowns:

Stores rooms in which stores infested by micro- organism have been kept should be periodically disinfested as shown below especially before the stores rooms are utilized for stacking uninfected materials.

- (i) The room should be emptied of all infected materials and thoroughly cleaned
- (ii) The wall should be white washed.
- (iii) The floor should be washed with phenyl or creosote liquid. If the stores room contain stores infected by insects the following measures should be adopted.
- (iv) The room should be emptied of all infected materials and cleaned thoroughly.
- (v) The room should be fumigated with Gammoxine smoke generators and kept closed for 12 hours or if the walls have not been freshly white washed for 15 days after the fresh white wash of walls 5% DDT solution or emulsion should be sprayed on the floor and on the walls up to a height of about 10 feet. Three pints of 5% solution or emulsion will suffice for spraying an area of 1000 sq. feet. The

dunnage should also be similarly sprayed with DDT. The spraying should be repeated at intervals of six weeks.

1.4.5. Cleaning of Metallic Stores

a) There is no universal method of cleaning by which a given surface can be properly cleared and dried prior to the application of the protective coating. This depends on:

- The nature of the contaminants to be removed
- The materials from which the item is made
- The complexity of constructions
- The kind of surface furnish
- The available materials, plant and equipment
- Size and weight

And after the due consideration, choice of the most suitable method will be made from the following

b) Degreasing:

Trichloroethylene (Vapour Immersion)

This method can be used for stores made of any kind of metal and subsequent rinsing is unnecessary, if the stores are not hot when removed from the vapour and dry off spontaneously. Stores must be allowed to cool to room temperature before the protective coating is applied. This method should not be used to:

- Stores containing rubber or other non-metallic materials
- Stores possessing cavities etc. from which it would be difficult to remove the condensed solvent.
- Stores containing internal lubricants, which it would be undesirable to remove i.e. universal joints, ball or roller bearings, vehicle load springs.

Method:

The stores are loaded into the wire mesh baskets or trays, care being taken to position the stores so that condensate can drain away and lowered SLOWLY by means of the overhead hoist into the vapour until the basket or tray rests on the perforated metal platform inside the tank. The lids of the tank should be replaced while degreasing take

place. The vapour condenses on the cold surface of the stores and the condensate dissolves the oil or grease taking it away to the sump of the tank.

Condensation will only take place while the stores are colder than the vapour, if, when condensation on the stores ceases (This will be indicated when the vapour rises above the stores and condenses on the cold water pipe near the top of the tank), all the oil or grease has not been removed, the stores can either be withdrawn from the tank, allowed to cool to room temperature and re-immersed, or alternatively, when the tank is fitted with a foot pump attachment and while the stores are still in the tank a stream of hot liquid solvent can be directed over the stores to complete the degreasing.

c) Hot Alkaline Solution

Although this method is efficient, it takes much longer than the trichloroethylene method, and has the added disadvantage of the stores having to be washed rinsed and dried after degreasing, therefore this method should only be used when the installation of a trichloroethylene tank is impractical. This method can be used for stores made of steel, copper and its alloys, provided the stores have no highly finished surfaces or inaccessible cavities, but should not be used for stores made of metals which would be adversely affected by alkalis i.e. zinc based die- casting, aluminum magnesium or its alloys. If any doubt arises as to the type of metal of which stores are made, expert advice should be obtained.

Method

The stores are loaded into the dipping baskets or trays as for the trichloroethylene vapour process and lowered slowly by means of the overhead hoist into the hot solution. The lids of the tank should be replaced while degreasing takes place, which is generally 10 to 20 minutes according to the amount of grease to be removed.

After degreasing, the solution should be allowed to drain from the stores and they should then be washed immediately in hot running water at a temperature not less than 82 degree C (180 degree F) THE SOLUTION MUST NOT BE ALLOWED TO DRY ON THE STORES. After washing, the stores will be rinsed in clean hot water and dried.

d) White Spirit

May be used for cleaning stores by hand when:

- (i) The volume of stores to be cleaned does not warrant the installation of special plant i.e. Trichloroethylene tank
- (ii) Stores are too bulky to be passed through the trichloroethylene or alkali plant.
- (iii) Stores incorporate materials such as rubber, leather or textiles, which would be adversely affected by complete immersion in solvents.
- (iv) It is important that internal lubricants applied to certain stores i.e. universal joints, vehicle load springs, and ball or roller bearings etc. are not removed.

Method

The solvent should be contained in twin tanks each fitted with draining platform.

As the first tank oil, the solvent aided by brushes, cotton rags and pads of hessian wash grease and other residues away. The stores are allowed to drain and then rinsed in the second tank, again allowed to drain, then dried with clean rags.

e) Steam Johnny degreasing equipment -

For degreasing large stores such as vehicle chassis.

f) De-rusting:

Rust removing solution (Cold immersion-Phosphoric Acid).

The full strength is diluted with an equal quantity of water before being added to the tank and owing to the risks involved in working with such acid solutions, it is ESSENTIAL that only the approved materials (diluted as directed) is used and every care is taken to avoid splashing. The solution is not suitable for defusing.

- Cast Iron
- High grade cutting steel
- Spring steel
- Welded parts
- Stores having rubber, leather textile or timber parts.

Method

Stores requiring de-rusting should first be degreased by one of the processes shown in the previous section. Stores for de-rusting should be lowered SLOWLY into the acid solution by means of the Overhead hoist, and allowed to remain immersed until removal of rust is complete. The time taken to complete de-rusting will vary according to the

amount of rust on the stores, but will generally be between 5 to 30 minutes. It is therefore necessary to inspect the stores periodically during the process to ensure that they are not immersed longer than necessary. The scum on the surface of the solution must be removed frequently to prevent contamination of the stores on removal. When removed from the solution, stores are suspended over the tank and allowed to drain before being washed thoroughly in running water and dried.

g) De-rusting by hand:

- Where the volume of stores does not warrant the installation of special tanks etc.
- When patches of rust have to be removed from stores too large for the tank process.
- For de-rusting stores for which the acid rust removing solution cannot be used.

Note: When cleaning the stores by hand, the degreasing and de-rusting processes may be combined, stores for de-rusting being transferred from the first white spirit tank to a nearby bench for de-rusting and then given a second wash in the first tank and a final rinse in the second. UNDER NO CIRCUMSTANCES SHOULD ACID BE USED FOR DE-RUSTING BY HAND.

Method

The method depends on intelligent use of the following, which in conjunction with the white spirit, are used to secure off the rust.

- Pads of Hessian
- Clean rags or cotton waste
- Wire brushes
- Steel wool
- Emery Cloth
- Buffing machines

Choice of the above will depend largely on the amount of rust to be removed and the nature of the surface to be cleaned. Generally all are suitable for stores of accessible shape, with no critical surfaces and the least severe method to achieve the desired results should be used.

It is essential that once the cleaning process has commenced, gloves be worn at all times. Finger- prints can cause corrosion and their removal requires special cleaning processes.

(h) Cleaning non-metallic stores:

The cleaning of stores made from timber, leather, rubber, textiles, cordage, and plastic etc. generally entails nothing more than removing dust by the most suitable available means i.e. brushes, clean rags, air blower, vacuum cleaners.

1.5. HANDLING AND PRESERVATION OF SOME SPECIFIC CATEGORIES OF GOODS**1.5.1. HANDLING AND STORAGE OF INDUSTRIAL GASES IN CYLINDERS**

Proper care is important for storage of various gases contained in compressed conditions in steel cylinders/bottles. In addition to damages of explosion, gases may be toxic, have burning effect or provide a fire hazard. Industrial gases may be in the form of permanent gases like oxygen, nitrogen- liquefiable gases like carbon dioxide Nitrous oxide and flammable gases like hydrogen, dissolved acetylene etc.

1.5.1.1 Storage License

If a consumer is required to store industrial gas cylinder containing high pressure in appreciable number in the premises, a licensed storehouse has to be provided duly approved by Chief Controller of Explosive, Nagpur or Regional Offices as the case may be. License for storage shall be required only when the number of cylinders to be in the premises at any given time exceeding the following:

1.	LPG	total 100 KG in cylinders
2.	Flammable but non toxic gases (Say hydrogen)	15 cylinders
3.	Nonflammable and nontoxic gases (say oxygen, nitrogen)	50 cylinders
4.	Toxic gases (say chlorine, ammonia)	5 cylinders
5.	D. A.	15 cylinders.

In conformity with Gas Cylinder Rules, 1981, application in Form C along with drawings and requisite fee is to be submitted to Chief Controller of Explosive, Nagpur for grant of license in form F to store compressed gases in cylinders.

1.5.1.2 Periodic testing of cylinders:**Requirement of testing of cylinders as per Gas Cylinder Rules 1981 is as under:**

“Periodic testing of pressure vessels in service- (1) all vessels shall be hydraulically tested by a competent person at a pressure marked on the vessel at interval of not more than five years after the date of first test, provided that in the case of vessels, containing

corrosive or toxic gases, the periodic test shall be done at an interval of two years. (2)
The competent person carrying the test as required under rule (1) shall issue a certificate of test.”

Rules further say, **“A cylinder for which prescribed periodic re-test has become due shall not be charged and transported until such re-test has been properly made.”**

1.5.1.3 Owner’ records

Owner of cylinder shall keep for the life of each cylinder, a record containing the following information regarding each cylinder, namely

- Cylinder manufacturer’s name and rotation number.
- The specification to which the cylinder is manufactured.
- Date of original hydrostatic Test/ Hydrostatic Strength Test.
- Cylinder manufacturer’s test and inspection certificate.
- Number and date of letter of approval granted by Chief Controller.

In order to meet above requirements, certificate/approval is obtained from the cylinder manufacturers as and when new cylinders are purchased.

When getting cylinders after refilling, we should insist that the supplier meet following requirements of ‘warning label’.

- Every cylinder shall be labeled with the name of the gas and name and address of the person by whom the cylinder was filled with gas
- A warning in the following terms shall be attached to every cylinder containing permanent or liquefiable gas, namely

WARNING

Gas cylinder rules 1981

- Do not change the colour of this cylinder
- This cylinder should not be filled with gas other than the one it now contains.
- No flammable materials should be stored in the immediate vicinity of this cylinder or in the same room in which it is kept.
- No oil or similar lubricants should be used on the valves or other fittings of this cylinder.

- Please look for the next date of test, which is marked on a metal ring inserted between the valve and the neck of cylinder, and if this date is over, do not accept the cylinder.

1.51.4 General safety for storage and handling of gas cylinders:

- (a) Cylinder shall be stored in a cool, well-ventilated place under cover, away from any source of heat and stores shall be easily accessible.
- (b) The storage room shall be of fire-resistant construction and designed in consultation with Explosive Authority.
- (c) Store and use D. A. cylinders in an upright position to prevent loss of acetone, which is used as a solvent.
- (d) Cylinders containing flammable gases (Hydrogen, DA) and toxic gases (chlorine and ammonia) shall be kept separated from each other and from cylinders containing other gases by maintaining adequate distance or by suitable partition walls.
- (e) Cylinders shall not be stored along with corrosive substance.
- (f) Empty and full cylinders shall be stored separately and all valves shall be tightly shut.
- (g) Protect cylinders from mechanical damages (while handling, not allow to fall one upon the other, sliding or dropping)
- (h) Use specific design holder for moving cylinders by hoist, crane and truck. Do not handle with electromagnets, ropes and slings. For manual handling provide sturdy hand trucks mounting one or two cylinders.
- (i) Maintain cylinders and accessories in good condition. If safety relief devices become defective promptly remove the cylinders to out door and return to supplier for repair. Always ensure that caps are fitted on the valve when cylinders are not in use.
- (j) Warning notices “No naked Light”, “No smoking” shall be prominently displayed outside/inside the building used for storage of cylinders.
- (k) Open the gas valve slowly to maximum. Open acetylene valve only one and half turn.
- (l) Electrical installations and fitting in a storage area for flammable gases must be flame-proof construction conforming to relevant Indian Standard specifications

1.5.1.5 Measurement of quantity of gases in cylinders

For oxygen, nitrogen, argon (Gr. I, II, III), Helium, Neon and Krypton.

Step 1.

Read the water capacity (Gauged in, next to cylinder No.

Step 2.

Take pressure of the gas. If less than 1800 PSI (135 KG SQ.CM) or more than 2000 PSI (150 KG SQ CM) reject the cylinder since it can cause explosion.

Step 3.

For every 1 liter water capacity there is	=0.1223 Cu. m oxygen.
	=0.1225 Cu. m Nitrogen
	=0.1230 Cu. m. Argon Gr. I
	=0.1232 Cu. m. Argon Gr. II
	=0.1238 Cu. m. Argon Gr. III
	=0.1224 Cu. m. Comp. Air.
	=0.1234 Cu. m. Helium
	=0.1242 Cu. m. Neon.
	=0.1248 Cu. m. Krypton.

For DA, Freon (all grades) and Carbon dioxide.

Step 1.

Read tare weight gouged into the cylinder by manufacturer =TW

Step 2.

Take filled WT. of cylinder in KG. = FW

For Freon and carbon dioxide quantity in KG = FW – TW at minimum pressure 14.5 KG/Sq. CM= Quantity of gas.

Step No. 3 (for DA Gas)

Take empty weight of cylinder in KG = EW

TW – EW = amount of acetone consumed by user (1Kg DA Gas = 0.91M^3 at 15^0C)

1.5.1.6 Detection of leakage of gas cylinders:

- (a) Normally, a cylinder may loose gas it contains during storage by leaking from valve shut off spindle or spindle gland nut in case of permanent and liquefiable gas cylinders and additionally from safety disc or safety plugs in case of DA.

- (b) Fill up the valve outlet socket with water, look for any gas bubble escaping and then drain water.
- (c) Apply soap water with a brush on the safety disc or safety plug or spindle gland nut and look for gas bubbling.
- (d) A mild tightening of spindle or safety plug etc. will, sometime, stop the leak.

1.5.2. Storage and handling of petroleum products:

Deterioration of petroleum products may occur due to carelessness in handling and bad storage conditions. The products which are deteriorated, cannot be used for the purpose they are meant for:

1.5.2.1 Causes of Deterioration:

- Vapour losses:
- Contamination
- Exposure to atmospheric conditions (Oxygen, temperature and light)
- Growth of Microorganism.

(a) Vapour losses:

- Vapour accumulated may be lost due to breathing caused by daily temperature variations- day & night
- Vapour may also be lost by suction created by winds, when tanks are not airtight.
- Evaporation increases with rise in temperature, increase in vapour space, and increase in surface area and decrease in humidity of air.

A certain amount of evaporation of petroleum products in bulk is unavoidable, particularly in hot climate but can be reduced by:

- Adequate maintenance of pressure and vacuum valves.
- Attention of closure and joints for vapour leakage.
- Turnover of stock in strict rotation.
- Keeping the tanks as full as possible i.e. reducing vapour space.
- Heat deflection paints to control high temperature. Spraying water in hot climate may do physical cooling.

Keeping them under cover and closures airtight can reduce evaporation of packed products

(b) Contamination:

Contamination in petroleum products may be due to:

- Mixing up of various grades
- Contamination with water
- Contamination with dirt, dust, grit, rust and corrosive substances etc.

To prevent admixture with other grades, pipeline equipment including flexible and containers shall always be marked correctly.

The presence of water in bulk fuel is inevitable through condensation of atmospheric moisture drawn in during the normal breathing of the tanks. The removal is affected by proper setting in Main Tank and by draining off level of water bottom rise to within 15 cm. of the bottom of the outlet connection.

Ingress of these contamination can further be controlled by using rust free equipment, properly closed/covered by proper settling in main storage and by use of adequate filters in filling points.

(c) Exposure to atmospheric oxygen, high temperature and lights:

Exposure to atmosphere leads to oxidation. High temperature and light accelerate oxidation process. To control this deterioration, petroleum products should be kept properly closed as far as possible, under cover.

(d) Growth of Micro-organism

Hydrocarbons in presence of water represent source of key nutrient for the growth of microorganism, which appear in the form of bacteria and fungi.

1.5.2.2 Storage and dispensing of packed lubricants:

Apart from determining most suitable lubricants for application, it is to be ensured that they are stored and preserved properly so that they do not deteriorate and lose their characteristics. A well-planned and efficiently organized POL stores will repay initial costs handsomely, benefits being:

- Reduction in machine downtime due to lubrication breakdown.

- Reduction in cost due to elimination of wastage and contamination and
- Reduction in oil stores labour cost due to efficient handling and operation procedures.

1.5.2.3 **Locating of Lubricant Stores:**

The ideal location for a POL stores shall have the following characteristics:

- A good reception area with free access for delivery vehicles, ample room for unloading and free exit for empty vehicles.
- Well-equipped unloading dock with direct access to Oil Stores.
- A location that minimizes the work needed to get lubricants to the point of use.

1.5.2.4 **Reception of lubricants**

- Usually the lubricant drums are delivered in trucks and shall be unloaded with proper equipment to avoid any damage to packages, their contents or injury to personnel.
- Overhead hoists (Fig 1) at POL stores shall be of considerable help both in unloading and subsequent stacking.
- A Forklift truck may also be very useful for these operations.
- Alternatively provisions can be made for unloading deck at average height of the delivery platform of the truck and a drum hoist for stacking
- All containers shall be checked to establish that they are not damaged, seals are intact, marking of lubricant grade are clear and receipts are as per invoice/order.

1.5.2.5 **Ingress of Moisture:**

All drums need protection from rainfall and condensation, mostly because of damages of contamination. After prolong exposure to corrosive atmosphere, the paint on the container may flake off and lead to obliteration of marking and eventually rusting of outer space. This may cause serious contamination and loss of contents.

Care shall be taken to prevent water entering in drums and special precautions are needed to guard against the ingress of moisture as a result of expansion and contraction with daily heat and cold.

1.5.2.6 Storage of Drums:

If the drums are left standing in the open, uncovered than (rain) water can easily collect on the top, on the lids. Since drums are stored upright, water may enter inside during the breathing process due to changes in temperature. Although Oil Companies claim that seals of bungs are airtight; over a period they may become

oil dry, air born moisture may enter the drums and gradually contaminate the products.

It is therefore essential that seals be always wetted by the contents. Drums shall be stored horizontally and bungs below the level of oil i.e. 3 O' clock and 9 O' clock position so the seals cannot dry out and also no breathing of drums (Fig. 2). Keep grease drums standing upright to avoid spillage. If the drums are required to be stores in the open area, they shall be covered with tarpaulins. Drums shall further be stacked grade-wise for proper issue and accounting.

While stacking the drums as above proper dunnage shall be provided. They can be stacked three high, properly wedged to prevent movement. Keep sufficient space between rows and drums for easy movement. The principle of "First in First out" shall strictly be followed for issue from stores.

1.5.2.7 Dispensing of lubricants:

Dispensing area shall be covered and properly protected. Once the drum is opened, their contents become more prone to contamination and misapplication. If the area cannot be locked it shall be under constant supervision. This is necessary not only to prevent misuse but also eliminate risk of using wrong lubricant, if unauthorized persons have access to use area.

1.5.2.8 Stores Lay-out

The storage building shall be designed in consultation with Oil Company. It shall, however, be well ventilated, lighted and kept neat and clean. The door shall be large enough to facilitate movement of forklift truck.

The floor shall be hard to withstand weight of products and also equipment. It is further to ensure that floor is suitably slanting so that oil spillage, if any, is easily traced.

Suitable Fire extinguishing appliances shall be provided in the building in consultation with the Fire & Safety Department or any competent authority.

1.5.2.9 Good House-keeping:

- (a) It is essential that lubricants be dispensed only from and into thoroughly cleaned containers. There shall be a drip tray to avoid spillage on floor. Brass taps, which can easily be screwed into bungholes, should be fitted to the drum for easy withdrawal.
- (b) Measuring cans with easy pour spout shall be used so that amount of oil issued can be recorded. It shall be advisable that dispensing is done with Barrel Pumps, which shall help in faster issue without spillage.
- (c) If the issue of greases is sufficient, Grease Dispensing Equipment shall be provided otherwise metallic paddles should be used for this purpose. Use separate paddle for each grade of grease. In no case withdrawal of grease by hand or with a wooden stick should be allowed.
- (d) Empty drums shall be received back from user department and stored properly in a separate area and disposed off in the most economical manner. If the disposal is fast better returns are possible as longer storage of empty drums result in their deterioration.

1.5.2.10 Receipts and disposal of used oils

Used oils from user departments shall be received back and properly accounted for and stored in a separate area, away from Oils Stores building/open yards. Used oils have substantial residue value and can be

- (i) Processed at site by installing a small Purification Plant as per the advice of oil companies.

- (ii) Sold to agencies empanelled with oil companies who are in the business of processing/purifying used oil.

As storage of used oil is a big fire hazard, disposal shall be as fast as possible. It is, however, to be ensured that the products from leaking drum, if any, are promptly transferred to good drums. Area shall, however, be kept clean rags/cotton waste used by the personnel shall promptly be picked up for disposal. Spillage, if any, shall be cleaned from time to time

1.5.2.11 **Operation of Petrol Pump:**

- (a) A petrol pump can be constructed after permission from the Oil Company, no objection certificate from the District Authority, approval of layout drawings by the office of Chief Controller of Explosive. For operation of Petrol Pump license for storage of specified quantity of both MS and HSD is to be obtained which is renewable periodically by paying requisite fee.
- (b) Proper fire prevention and fighting arrangements need to be made. It is further to be ensured that only flame- proof electrical fittings and fixtures are used at petrol pump. Area should be kept neat and clean and no waste cotton pieces, rags, dirt, grit etc. are allowed in the area. There shall always be a small office at the installation for operator and also records. The areas shall further be fenced for security of the pump with a large size door having locking arrangements. No smoking and other warning boards shall be displayed at suitable places.
- (c) **Receipt of MS/HSD tankers:**
The following precautions shall be taken before unloading the products from the tankers.
 - If weighing facilities are available, gross weight of the tanker may be obtained and after unloading, tare weight shall be obtained. This helps to establish approximate quantity of the product and detect major loss.
 - Tankers should not be unloaded immediately after arrival. It should be parked on a leveled area for sometime so that the product is settled down. After about half an hour, measurement of each compartment should be

taken with dip- stick available with tanker operator to ensure that invoice quantity is received. If in any compartment, shortage is noticed, product shall be poured from the under ground tank with the help of measuring can to determine exact amount of shortage.

- With the help of dip stick quantity of product in the underground tank shall be determined both before and after unloading the tanker. This again helps to find out major shortages.
- Apart from dip measurement from the dip hole of the tanker, dip measurement from the loading hole (larger in size) may also be taken. This again will only be approximation but major loss of the product on way may be detected.
- Before unloading, it shall further be ensured that tanker is connected to the under ground tank.
- While acknowledging receipt, details of shortage, if any must be mentioned so as to claim from Oil Company.

(d) Maintenance of dispensing Units and stamping by Weight & Measurement department

The oil companies undertake maintenance of dispensing units and if any defects are noticed they should be informed immediately. Owners are advised not to temper with the dispensing unit. As a normal practice accuracy of dispensing unit should be checked every morning by measurement of products with 5 Litre certified measuring can. In case any variations are noticed the unit shall be readjusted by representative of W&M department and technician from Oil Company. The dispensing unit needs to be checked by Weight & Measurement department every year and after satisfactory results they stamp those and they issue a certificate.

A copy of certificate from W&M department and License from office of Chief Controller of Explosive shall be displayed in the office.

1.5.2.12 Aspects to be monitored for reducing consumption of POL

- Selection of right lubricant for given application
- Prevention of contamination of lubricant in service.
- Precautions to avoid early deterioration of lubricants while it is in use.

- Extension of useful life of lubricants.
- Purification of lubricating oil for reuse.
- Finding alternate use for used lubricants.
- Prevention of leaks/losses of lubricants.
- Providing good storage conditions and handling by trained people.
- Lubricants adjusted for right feed.
- All loose systems eliminated.
- No over filling done.

1.5.3. **Storage and Preservation of Rubber Goods:**

Main factors causing deterioration of rubber goods are (a) light; particularly sunlight rich in ultraviolet rays (b) air flow (c) Ozone (d) heat (e) organic solvents and oil (f) acid and alkalis (g) mechanical stress, strain, sharp bends and folds (h) copper, manganese and their compounds and (j) grit, dirt dust etc. Fungal growth can also occur under favourable conditions of temperature and humidity which by itself, although not damaging, but presence of pathogenic organism is a potential danger in respirators and similar articles.

1.5.3.1 Main symptom of deterioration is development of tackiness and softness, crack development, surface crazing, brittleness, loss of shape, fungal growth and tendering of rubberized fabric.

1.5.3.2 **Following are some of the precautions for storage of rubber goods, which shall prolong their useful life:**

- (a) Storage room should be of permanent construction, dark and cool as far as possible. Its temperature should not increase 27 degree C.
- (b) Ventilation should be restricted to minimum to avoid airflow as they supply fresh oxygen. A slow circulation of cool air is desirable.
- (c) Rubber goods should be stored away from (a) electric generators/motors, switch gear etc as they produce ozone in their vicinity and (b) acid and alkalis.
- (d) Contamination with oils greases and organic solvents should be avoided. Greasy and oily spots on rubber stores should immediately be removed with little petrol, then thoroughly wiped dry and dusted with fresh chalk powder.
- (e) Contact with copper and manganese, their alloys and compounds should be avoided.

- (f) Mechanical strain and distortion to rubber should be avoided during storage, as these increase susceptibility to oxidation.
- (g) Contamination with grit, dirt and dust should be avoided.
- (h) Rubber stores should generally be turned over quarterly and liberally dusted with French Chalk Powder except all rubber tubing intended for blood transfusion and those used in connection with petroleum products. These should be internally treated with 20% solution of pure glycerin in water after blocking both ends. French chalk should be freely dusted externally. Rubber bellows, diaphragms and hinging materials should occasionally be wiped lightly with 20% of pure glycerin in water to prevent hardness.

1.5.3.3 **Stacking of Tyres:**

- (i) **New tyres of vehicles should be stacked in one of the following ways:**
Vertical stacking in racks of the horizontal; parallel rounded supports (e.g. poles, M. S. Tubing) should be spaced out by such a distance that when tyres are vertically resting across then $\frac{1}{3}$ of the circumference of the tyres will thus be resting lightly by their tread on two points. Vertical supports should be provided at suitable intervals to keep the tyres upright.
- (ii) **Horizontal stacking:** Tyres should be stacked flat one on the top of other to a height not exceeding 2 meters on a leveled floor or platform. Mixing of sizes in a stack should be avoided. If it is necessary to pile different sizes in one stack, the smallest and lightest should be near to the top and the largest and heaviest one below. All the tyres should be centred properly.

Used tyres should be cleaned before being put into storage. Methods of stacking are as for new tyres.

1.5.3.4 **Mounted tyres:**

- (i) When mounted tyres are stored off the vehicle, they should be removed and refitted after wheel rims are cleaned and painted. Tyres shall be examined for embedded nails, flints etc. Punctured and defective valves shall be repaired. The pressure shall be kept low and assembled piled

horizontally as stated above; the height of the stack should not exceed 1.5 meters.

- (ii) The pressure of mounted tyres should be reduced to 50% and the vehicles on which they are mounted, raised from the ground level so as not to rest on the wheels.

Motorcycle and bicycle tyres should be hung over two parallel horizontal poles.

1.5.3.5 Storage of Tubes:

These should be dusted with French Chalk Powder and packed in cartoons or bags and kept in boxes or shelves. Tubes fitted in tyres should be slightly inflated.

15.3.6 Rubber Hoses:

The hoses shall be kept uncoil or in loose coils in rack or boxes. Not more than 3 or 4 coils shall be stacked one above the other. After use, the hoses should be allowed to dry in shade before being stored.

1.5.3.7 Rubber Sheets:

After dusting with French chalk, the sheets should be rolled and stored in close shelves or boxes.

1.5.4. Storage & Preservation of Paints:

1.5.4.1 Causes of Deterioration

If the drum is leaky near the bottom, the paint will be lost through leakage. If it is leaky near the top, or if its closure is not adequately sealed, the following defects will occur.

- The thinner will evaporate, leading to a thickening of the paints, and
- Air will have free access into the top of the drum and cause the drying of the upper layers of the paints, thus forming a scum, which cannot be used.

If paint is left undisturbed for long time, the heavy pigment tends to settle down and ultimately cakes at the bottom. Once the cake become hard, the paint becomes unserviceable. Due to the long storage and under adverse storage conditions, paints may form a jelly like mass, which is useless.

1.5.4.2 Precaution to be taken during storage of paints, enamels, varnishes and allied products:

- (a) Paints, enamels, varnishes and allied products should be kept in a cool dry place, preferably on a bed of dry sand- 8 cm thick, in leak proof, properly sealed/stopped, rust free container. All leaky containers should be changed as soon as leakage is noticed.
- (b) Buckets of sand (instead of water) should be kept ready for use in case of fire. Fire extinguishers should be of foam type. Cotton, jute and such other materials soiled with paints must not be allowed to accumulate. They should be promptly disposed off.
- (c) Contamination of these stores with water should scrupulously be avoided
- (d) Sealed paint drums should be rolled and turned about and re-stacked.
- (e) Paint drums from which some paint has been drawn should be stirred once a month by means of a rod and closed securely again.
- (f) The paints and allied products should be drawn from orifice provided for the purpose and not through hole indiscriminately punched in the tin. If a proper cap is not available for the orifice, the latter should be closed by means of a tapering wooden plug.

1.5.5 Storage and preservation of Chemicals and Alkalies

1.5.5.1 The general causes of deterioration of chemicals are:

- Heat
- Light (including direct sunlight)
- Air and moisture.

Chemical should therefore be stored in their original package in cool dry and well ventilated places. The containers of chemicals should be opened for the minimum period necessary. The packs and containers of chemical should be examined (at least once in three months) for leakage due to loose stoppers or damaged containers. Precaution to be taken during handling, storage and use of certain classes of chemicals are given below:

1.5.5.2 ACID

- (i) Room where acids are stored or used should not be slippery and must be kept clean.
- (ii) Bottles or carboys should be away from direct sunlight
- (iii) Separate shelves or compartments should be provided for each type of acid. Nitric acid should be kept as far as possible, away from sulphuric acid and hydrochloric acid.
- (iv) Heavy and PVC containers with acid should be stored on a bed of dry sand about 2"-3" thick.
- (v) Foreign materials such as sawdust, cotton, paper or chips of wood must not be allowed to fall into the acid.
- (vi) Acids should on no account be mixed.
- (vii) Pail of clean water and neutralizing solutions (10 to 20% soda ash solution) should be placed in or near the stores rooms.
- (viii) Acids should be handled with great care to prevent spilling. If any acid is accidentally spilt, it should promptly be washed down with neutralizing solution and water.

1.5.5.3 **Alkalis:**

- (i) Ammonia liquid bottles should be cooled with water (preferably iced water) before opening and should be opened with the mouth of the bottle directed away from the person.
- (ii) Alkalis should be stored as far away from acids, as is possible, preferably in separate room.
- (iii) As caustic soda and potash absorb moisture from air, their containers should always be closed and air tight.

1.5.6. **Storage and preservation of batteries**

- 1.5.6.1 (i) Care should be taken that cells are stored in dry and well-ventilated stores and protected from extreme heat and cold. Condensation provides a leakage path and heat increases the rate of chemical reaction, leading to failure. In storing dry cells, care should be taken that their terminals do not touch and that no articles are placed on them, which are likely to cause short circuits.

- (ii) Storage batteries should be recharged to their initial value at least twice a month during storage when not in use because if it is allowed to stand in a discharged condition, the soft lead sulphate first formed gradually becomes hard and granular and the hard lead sulphate resists recharging. The level of electrolyte in accumulators should be examined frequently and any deficiency in the level is replenished.
- (iii) Sawdust should never be used for packing batteries, as it is hygroscopic. They are always to be wrapped individually in waxed paper, and shaving used for packing.
- (iii) Torch batteries deteriorate by being allowed to remain in the torches when not in use. All batteries are to be stored so, as to allow a free current of air to circulate between the tiers and both ends should be easily opened to inspection.
- (iv)

1.5.6.2 Batteries, Nickel Iron:

The following instructions should be complied with in regard to the care and maintenance of batteries.

- (i) Storage conditions should be as clean, dry and cool, as possible, but low temperature should be avoided.
- (ii) The cells should be examined every 3 months; any corrosion produced removed and exposed parts greased.
- (iii) No naked flames should be brought near the cells during charging and the space, in which the cells are charged, should be well ventilated.

1.5.7 Storage & preservation of Cement:

1.5.7.1 Prolonged storage of cement, where moist air may gain access, decreases the strength of the cement and make it appear to be coarser and amount of water required to make up a neat cement paste of standard consistency increases and setting time is also increased. In worst cases lump formation even render the cement unusable.

1.5.7.2 Precaution in storage and handling:

- (i) Cement shall always be stored in dry and leak proof godown, not more than 10-12 bags height.

- (iii) Stacking shall be done by providing proper dunnage of wooden sleepers/planks and should be at least 80 cm. away from the walls.
- (iv) Bags shall not be handled by means of hook. This results in loss of cement and also torn out bags fetch less amount when disposed off.
- (v) If storage is required for longer period, the stack shall be reshuffled every three months. This shall help in minimizing lump formation.
- (vi) The area shall be swept periodically and sweep cement can be used for minor repair works.
- (vii) The principle of “First in First out” shall strictly be followed so that older lots are issued on first available opportunity.
- (viii) Stacking shall be done grade-wise to eliminate chances of mixing.

1.5.8 Storage and preservation of bearings

1.5.8.1 In order to maintain the fine surface finishes and geometrical precision of bearing raceways and rolling elements, it is necessary that each step in the handling of bearings is carefully controlled to avoid the introduction of foreign materials in the bearing surface, of the raceway. If bearings or associated shaft and housing parts are allowed to accumulate a layer of dust, the bearing will subsequently operate with action of the abrasive dust. Environment around high precision bearings, high-speed bearings and small size bearings should particularly be kept clean.

Furthermore, care must be taken not to give any severe impact to bearing, as this can cause dents and damages to the raceway surfaces, this would cause unsatisfactory service and premature bearing failure

1.5.8.2 Following are some of the precaution; we should take to preserve bearings:

- (i) When stored, the bearing should be kept in their original package to preserve them from deterioration. Removal from the package should only be effected at the assembly site immediately prior to mounting. Sometime original packing of bearings is disturbed for the purpose of inspection. It is therefore essential to repack them immediately.

- (ii) Larger bearing, because of their relatively thin rings, should not be stored standing
Upright but laid flat. The support should extend over their whole circumference. It is advisable to avoid stacking the bearing on top of each other, since the bearing at the bottom of the stack will have rust preventive compound squeeze away from the bearing surfaces.
- (iii) Roller bearings are dipped in anticorrosive oil, which protects them from rust formation as long as they are packaged. There is neither gumming nor hardening of the oil and it is compatible with all commercial roller bearing greases.
- (iv) Bearings should be stored in shelves in dry room, preferably more than 30 cm. from the ground, where the relative humidity does not exceed 60%, as high humidity is the biggest cause of rust. The storeroom should be kept at a moderate constant temperature, as the rust preventive compound will tend to flow at temperature above 50 degree C.
- (v) Bearing with shields, suffix-2Z should however not be stored for more than two years prior to use, and bearing with seals suffix 2 RS, for not more than three years. Such bearing are lubricated for life but the grease will age out and become too stiff if kept too long
- (vi) The protection is only effective for longer periods of time if the bearings are kept in their original packing, clean, well oiled or greased and wrapped in rust inhibiting waxed paper in a dry and frost resistance room. Of course, no corrosive chemicals such as acids, ammonia or chloride of lime may be stored in the same room.

1.5.9. Storage & preservation of Optical Instruments:

1.5.9.1 Causes of Deterioration

The high temperature and humidity are the main factors causing following deterioration of optical instruments in general and optical surfaces in particular.

(a) Fogging

Fogging occurs due to condensation of moisture on the optical surface in imperfectly sealed instruments as a result of diurnal variations of temperature and is seen as a thick mist. Desiccating the instruments or warming it can remedy it.

(b) Filming

Filming though similar in appearance to fogging is of permanent nature. It occurs due to repeated fogging and formation of carbonate films on the optical surface. It may also occur due to deposition of fine droplets of oil or greasy matter on optical surface.

(c) Fungal

Fungal growth may occur because of presence of moist air inside the instrument due to breathing phenomenon, the food for fungi being provided by stray fiber of cloth, fingerprints, and dead insects. It etches the optical surface and look like a spider web.

1.5.9.2 Moisture is the most important causative factor in the development of various defects in optical instruments. Following are some of the precaution during storage and use.

- (i) Storage accommodation shall be as dry as possible. As far as possible, instruments shall be stored individually in airtight metal container in which silica gel is used as a desiccant.
- (ii) The equipment shall not be dismantled or reassembled without the help of experts.
- (iii) Polished glass surface should not be touched with hand as finger marks encourage fungal growth besides blemishing the surface.
- (iv) Shutter and diaphragms shall not be meddled with when fitted to a camera as they are duly desiccated by manufacturers before sealing them on the mount.
- (v) Oil, grease, if any, present on the optical surface should be cleaned by soft clean linen moistened with little alcohol/benzene/xylene.
- (vi) Front surface mirrors and bloomed optical components shall in no case be rubbed with linen. Particles of dust etc. shall first be removed by using a camel hairbrush and then the surface shall be cleaned with lightly moistened brush with alcohol.
- (vii) Graticule shall be cleaned very carefully so that markings are not damaged. Any stain or dirt shall be removed by gentle rubbing with a linen wet with alcohol and not hand rubbing as they may result in marking getting damaged.

1.5.10 Storage & preservation of Electronic Equipment and Components

1.5.10.1 Causes of deterioration

- (a) Electronic equipment is generally very sensitive, complicated and costly. Slight deterioration, in one or more components can spoil the function of the equipment. Bumps, shocks, vibration and compression are physical environment that affects this equipment. Variable condenses; resistors, relay etc are badly affected due to vibration. Pointer type devices may read false. Bump cause structural failure and shocks cause fracture of components like valves, resistors and capacitors.
- (b) High temperature changes the elastic properties of the spring in a moving coil mechanism and ultimately reading of the equipment changed. At low temperature pointer type devices losses its calibration. Plastic and rubber used as insulating materials loss their flexibility, short circuit may occur.
- (c) Humidity leads to corrosion of ferrous materials and swelling of water absorbing substances. It leads to fungus growth on rubber, paints varnish, electrical insulation, wood, and leather, silk or other materials. Light intensity may fad protective colouring.
- (d) The electronic equipment shall be saved from dust and sand.

1.5.10.2 Following precautions shall be taken during storage and use.

- (i) Mechanical damaging factors shall be eliminated by handling them carefully and providing suitable packing while moving. Necessary marking on boxes/cartons i.e. “Handle with care-Electronic Instruments”, “Save from Rains and Sunlight”, “ Keep the box upright” with necessary arrow marking etc. can help to reduce handling damages.
- (ii) Temperature should be maintained as specified for instrument for operation and storage by use of air- conditioned room.
- (iii) Equipment are sealed in dry, clean and dust free atmosphere.
- (iv) Periodical warming and cleaning of equipment is desirable.

- (v) Exposure to ultraviolet radiation of high intensity help in retarding fungus growth.
- (vi) The equipment should invariably be stored under covered accommodation.

1.5.11 Storage and preservation of Computers and Peripherals:

The effect of environment on computer system is basically the elaboration of the effect of temperature, humidity, dust, corrosion, Electro-static and electromagnetic fields. Mechanical vibration and shocks may also have effect on resistors, capacitors, and semiconductor devices, ICs and printed circuit board. Utmost care, therefore, shall be taken to prevent damages due to these factors during transportation, storage and operation.

Peripherals like floppy/drive mechanism, cassette/tape, printer/reader, CRT terminals are more susceptible to environment hazards due to very nature of their functioning and placement in the entire computer frame- work.

Floppy drives are quite susceptible to temperature and humidity. Presence of dust and onset of corrosion may cause hard errors. Mechanical vibrations and shocks also cause errors. Bending, applying pressure and making stacks (more than 10) should be avoided. Cassette tape/cassette tape drives shall also be handled in the same way as floppy.

Printers/readers are least affected by humidity, electrostatic or electromagnetic field or radiation. Temperature, however, limits their performance due to presence of semiconductor devices. Shocks and vibrations as usual mar the performance by causing mechanical damages.

In CRT terminals, the major factors are dust (which causes sparking due to high voltage), strong electrostatic and electromagnetic fields, which may affect the data.

It is therefore, obvious that the complete computer system is prone to environment hazards if not transported, stored and operated within the specified limits of tolerance.

1.5.12 **Electrical Equipment and Components:**

1.5.12.1 Effect of environment

The performance of electrical equipment and components is affected due to climatic hazards such as humidity, temperature, dust, corrosion etc. Effect of environment on some electrical equipment and component is as below:

(a) Transformers:

These are badly affected by moisture and dust. Insulation breakdown results in severe short circuit. The dirt accumulation on high voltage bushing results in discolouring of connections and excessive heat may cause a flash over at high voltage terminals. Low temperature can affect the moisture seals resulting in cracks.

(b) Motor/Generators:

The greatest cause of failure is the breakdown of insulation which may be brought about by absorption of moisture, oil, grease and dust into the winding and by excessive heat, vibration, over voltage and aging.

(c) Relays:

Atmospheric corrosion causes electrochemical action on fine wires of the relay coil resulting in open circuit of the coil. Failure of contact occurs in unsealed relays due to dust and moisture.

(d) Switches:

If left unused, the metallic parts of switches get corroded, resulting in poor contact/break. Undesirable contact can also occur due to accumulation of dust.

(e) Plugs, sockets and connectors:

The metallic parts of plug, socket, connector, control knobs, adopters etc get corroded, sometime very severely.

1.5.12.2 **Care & preservation**

- (i) Electrical motors and equipment must be stored under covered accommodation so as to save them from atmospheric conditions. Winding must be protected from humidity. The winding shall be checked periodically and so is isolation resistance.
- (ii) Mechanical vibration and shocks are eliminated by providing suitable vibration and shock mounds.

- (iii) Dust and salt mixed moisture will rapidly start corrosion in addition to increased leakage and growth of fungal attack. Therefore these must be removed from the surface of the equipment.
- (iv) Due to shortage of indoor accommodation if such equipment are kept outside, proper dunnage shall be provided and equipment shall be covered with tarpaulins.

1.5.13 Storage and handling of cable/conductor drums

1.5.13.1 Causes for deterioration cable drums

Moisture has the effect of reducing insulation resistance. Failure of die-electric occurs due to extreme conditions of heat, cold, ultraviolet radiation etc. Fungal infestation sets on cotton wiring, sleeve, and cable sheaths. Both types of deterioration simply or in combination are able to seriously impair the performance and service life of cables.

5.1.13.2 Storage of drums:

- (i) The site chosen for storage of cable drums shall be well drained and should preferably have a concrete surface, which shall not cause the drums to sink and so lead to difficulties in moving the drums.
- (ii) All drums should be stored in such a manner as to leave sufficient space between them for air circulation and movement of personnel for check, loading and unloading. A proper dunnage shall be provided before stacking the drums. It is desirable for the drums to stand on battens placed directly under the flanges. In no case shall the drums be stored on the flat i.e. with flanges horizontal.
- (iii) Multi drum stacking can be done in case of smaller size and lightweight drums. While stacking, it has to ensure that lower layer drums are not damaged during handling or due to weight of stack. Proper wedges are to be provided to stop movements of the drums.
- (iv) It has to be ensured that end-seals provided by the manufacturers are intact. In case end seals are lost or damaged, suitable sealing shall be done. In no case cable drums shall be stored without proper end sealing.

- (v) If the above conditions are observed when arranging site and storage, overhead covering is not essential except in the area where rainfall is heavy. The cable shall, however, be protected from direct ray of sun by keeping the batons of drums intact or by providing some form of sun shielding.

5.1.13.3. Handling of drums:

- (i) **Movement over short distance:** when drums of cable have to be moved over short distance of few meters, they may be rolled.
- (ii) Over a long distance from storage site to work spots, the drums shall be mounted on trailer or vehicle. Alternatively drums may be mounted on cable drum wheels strong enough to carry the weight, which shall be pulled by means of ropes.
- (iii) **Removing the cable from the drum:** The drum should properly be mounted on jacks on a cable wheel, making sure that spindle is lying horizontal in the bearing so as to prevent the drum creeping to one side or the other while it is rotating. Before removing the cable it is to be ensured that drum is free for movement.
- (iv) Empty drums in good condition shall be preserved properly for future use or replacement of damaged drums due to longer storage or handling. Possibilities of returning good drums to cable manufacturer can also be explored.
- (v) Cut pieces of cable/conductor shall be stored properly coiled/bundled with a tag indicating size, type and running lengths. This shall help in most economical use of cut lengths.

5.1.14. Storage of Medicines:

5.1.14.1 Causes of deterioration

Most medicinal substances or preparation whether of chemical or biological origin, are capable of being affected in such a manner as to vitiate or nullify their therapeutic usefulness. Possible causes include chemical incompatibility, acidity, hydrolysis, trace element, metals, atmospheric conditions light and heat.

As the medicines are “perishable items” (with limited shelf life) therefore their care and storage is of vital importance.

1.5.14.2 In order to control non-biological agencies, specific type of storage for various categories of medicine is necessary and should accordingly be provided.

- i) The drugs are liable to undergo chemical deterioration as a result of high temperature and in some cases, due to exposure to air, moisture and light. Medicines as such should be stored in cool and dark place.
- ii) Short life drugs, serum and vaccines lose their potency after the prescribed period. It shall therefore be ensured that they are consumed/issued within their life period.
- iii) While buying the medicines it shall be advised to the supplier that on date of supplies, medicines shall have minimum of 80% of their shelf life so as to minimize losses attributed to shelf life.
- iv) The important groups of medicines like injections, vaccines, and sera etc. should periodically be examined.
- v) On the basis of deterioration due to high temperature, the storage shall be classified in following two groups:
 - a) Medicines requiring storage at temperature below 10 degree C- example sera, anti-toxins, vaccines, antigens, penicillin, blood and plasma. These medicines as such shall be stored in a refrigerator.
 - b) Medicines requiring storage between 10 degree C to 26 degree C. Example Hydrogen Peroxide, ointments and liniments, tonic acids, essential oils and Ergot and its preparations. Such conditions can be provided by installing air-conditioner when such facilities do not exist storage shall be at dark place.
- vi) The container should be kept well closed, air tight and in good condition
- vii) Care in transportation, collection and distribution is of utmost importance, particularly in warm climate as any deterioration resulting from undue exposure to heat can not be restored by subsequent cool/cold storage.

1.5.15 Preservation and treatment of timber:

Substantial quantities of timber/wood products are stored in industrial undertaking. These products as such are also required to be protected properly.

1.5.15.1 The preservatives generally used for preservation of wood/timber are:

(a) Oil type:

Coal tar creosote and its mixture with mineral oil. This is the most ideal method of preservation of timber in direct contact with the ground, in outside location.

(b) Water Soluble type:

These preservatives are soluble in water and consist of salts like sodium penta chlorophemate, zinc chloride, boric acid and borax or combination of such salts. These preservatives are liable to be leached out and hence they can confer a satisfactory level of protection only when timber is protected from exposure

(c) Water soluble “Fixed type” preservations:

In this case the salt get fixed to the timber after it is dried, and offers greater resistance to leaching and offers protection to timber in exposed conditions.

(d) Solvent type preservatives:

These preservatives are used as solution in high boiling points or volatile organic solvent copper and zinc naphthlonates are examples:

1.5.15.2 **Methods of treatment:**

(a) Hot/cold or open tank process:

This process is adopted for all preservatives except solvent type preservatives dissolved in a volatile organic solvent. The timber is completely submerged in the liquid, which is then heated to an appropriate temperature (depending on the nature of the preservatives) and then allowed to cool to atmospheric temperature in the mixture. During the heating period, the air in the timber expands and is partially expelled; consequently, during the cooling period, penetration and absorption of preservative are facilitated.

(b) Cold soaking:

This process can be used in case of preservatives in volatile solvents or where hot/cold process is not possible. A short period is sufficient for treatment of these sections of timber, while the process is time consuming with thicker sizes of timber.

(c) Surface application.

This is done by applying the preservatives by brushing and spraying and is useful for treating freshly exposed surface of timber, which had already been treated. In

the case of brush treatment, two coats are applied, the second coat being given before the first one is dry on the exposed surface of timber, which had already been treated. When this type of preservations are applied, the moisture contents of the timber shall not exceed 10 to 14%, a moisture content of 20% to 30% is preferred for the soluble type.

Since it is not possible to give proper preservative treatment to wet timber, it is essential; that heavy structure timber should contain not more than 25% of moisture and thinner pieces not more than 17% at the time of treatment.

The treatment by hot/cold process is disinfective and protective i.e. they will kill insects and fungi already present in the timber and also confer protection on the treated timber against fresh attack. The cold soak process is effective as a disinfective measure if the period of soaking is at least 48 hours. Surface application of preservatives is of no use, as disinfective measure, its effectiveness, as a prophylactic treatment is also relatively low. The choice and duration of treatments depends on the presence or absence of infestation, the nature of the timber species and purpose for which it is used. If none of the above methods of treatment can be carried out due to various reasons, as a stopgap measure an immersion in water with DDT, protect to some extent.

1.6. Preservation of some high value and critical spares/ Materials of power plant

1.6.1 Pumps, shafts, impeller Assy./Gear Box (Indoor)

- (a) Pumps/Gear Boxes shall be stored in assembled condition in original frame. No inclination or external load is allowed on packing boxes.
- (b) Pumps end other opening are to be suitably plugged.
- (c) Apply grease /rust preventing oil coating for exposed portion of shafts and impellers.
- (d) Periodic rotation of rotors to avoid sagging and jamming of bearings.
- (e) Larger diameter and lengthy shafts are to be multi-supported at proper intervals.

- (f) Impellers are to be kept on vertical axis.
- (g) Shafts to be kept preferably indoors with rust preventive coating applied.
- (h) Rotor should be kept on stand to facilitate rotation.
- (i) Check rust preventive coating over impeller, bearing, if not, apply the same.
- (j) Threaded portion and key-ways are to be covered with PVC tapes or other preventive coating materials
- (k) Turbine rotor/generator rotor and motor may be kept in sealed packing.

1.6.2. Fans: (impeller, bearings, and pedestal (Indoor/weather protected outdoor.

- (a) Above ground on block support
- (b) When in out door, these shall be covered with tarpaulins and vented for air circulation- a gap of minimum 3—mm shall be made available between the components and it's covering.
- (b) Rust preventive coating for journal /other bare surface.
- (c) Shaft and impeller Assy. To be supported at suitable span to avoid sagging.
- (d) Periodical rotation for heavy shaft/rotor etc.
- (e) Impeller and shaft should preferably be kept indoor along with bearing assy. on the frames received from the shops.
- (f) Check rust preventing oil coating, if not, apply the same.

1.6.3. Suction Chamber (Out door)

- (a) Above ground on block and axis in vertical position.
- (b) Check rust preventing oil coating, if not, apply the same.

1.6.4 Mill Parts (Out door)

- (a) Suitable rust preventive coating on the machine seating/matching surfaces
- (c) Lay on leveled ground on blocks.
- (d) Rolls are to be kept vertical axis when stacked (Max. 3)
- (e) Ring shall be kept horizontally and stacking shall not be more than 2 on wooden sleepers with gay rope intact.

1.6.5. Boiler Tubes:

- (a) Ensure preserving end capping of tubes
- (b) Preserving the primer coating of outside surface as applied by manufacturers.
- (c) Preserving colour coding to avoid mix-up.
- (d) Since issues from stores of boiler tubes are very slow, they shall be stored in covered/semi covered sheds on special tube stands which shall be placed at suitable interval to avoid sagging.

1.6.6 ESP Collection Electrodes and AHP Heating Elements (In door)

- (a) Check rust preventive oil coating, if not, apply the same.
- (b) Provide multi support to avoid sagging and bending of CE.
- (c) CEs to be in original boxes horizontally.
- (d) Stack approximately 300 mm above the ground and not more than 3 boxes.
- (e) Original packing to be retained and humidity controlled with silica gel/ moisture absorbent. Silica gel to be checked/regenerated/replaced periodically as per the recommendations of manufacturer or as colour of silica gel changes.

1.6.7. Gear Boxes and motors:

- (a) Keep resting on its base.
- (b) No external loading, exposed shaft ends are to be covered with rust preventing oil coating and covered with polythene bags.
- (c) Rotors are to be rotated periodically, once in six months to avoid sagging as well bearing jamming due to drying of grease.
- (d) Terminal boxes of motor to be kept in sealed condition.
- (e) Gear- box should be kept filled with suitable oil up to working level to avoid rusting.
- (f) Silica gel / Moisture absorbent to be kept along with the motor and terminal box. Silica gel to be checked/replaced or regenerated periodically.

1.6.8 Transformers and winding coils (Indoor)

- (a) To be kept in upright condition.
- (c) Periodical heating of coils, if any, and oil filling of transformers as per manufacturer's guidelines.
- (d) Away from hazardous materials.
- (e) Low A. C. Voltage to be connected to LV side with fuse protection (10/15m) HV side is to be shorted. Transformers are to be checked regularly for voltage/current/temperature.
- (f) Keep the transformer coils in oil.

1.6.9 Columns/heavy beams/girders/structural steel (open yards)

- (a) Laid over suitable supports such that flange of the section rests on support.
- (b) Multi support at proper intervals to avoid sagging.
- (c) Machine faces of the column pieces as well other surface are to be applied with rust preventing oil coating.
- (d) No other materials to be kept over the columns.
- (e) Other structural components shall be kept above the ground on suitable supports

1.6.10 Valves:

- (a) Check rust preventive coat on body, hand wheels, butts welded ends/flanges and by pass tubes, if not applied, apply the same.
- (b) Rest the valve upright on wooden pieces,
- (c) Protect unpainted surface of valve components like stem, yoke, bush etc. with grease or preventive oil.
- (d) Keep valves always with disc/wedges closed,
- (e) Proper polythene bag covering for actuators and motor Assy. to be applied.
- (f) Glands packing are advised to be removed from valves if installation is delayed to avoid possible corrosion damages.
- (g) Valves ends/flanges opening are to be plugged with PVC caps.
- (h) Due to non-availability of covered area, certain heavy valves can be stored in open yards, concrete and after providing necessary rust preventing coatings.

1.6.11 Rotor of turbine/generator/HT motors (indoors)

- (a) Turbine/generator and motor rotor to be kept in suitable packing box, preferably original box from the supplier, properly supported and covered by tarpaulins/PVC sheets to avoid entry of dust, water, other foreign materials.
- (b) Journal and exposed metal surface shall be coated with rust preventing materials and covered with polythene bag/sheets.
- (c) Periodic inspection and replacement of silica gel type moisture absorbent for motor rotor/stator
- (d) Periodic rotation of rotor, once in six months by 180 degree and support bearings to be kept lubricated.

1.6.12 Welding Electrodes:

- (a) To be stacked on steel racks/cupboards
- (b) Stands made of moisture absorbent type materials like wood shall be avoided.
- (c) Cartons/polythene bags shall not be opened/removed other than required during receipt inspection (random)
- (d) Carton stacking to minimum height so as to avoids the damage to bottom layer boxes and electrode fluxes.
- (e) No external loading on electrodes.
- (f) Electrodes should be kept in hot air ventilated room, free from moisture (by installing dehumidifiers)
- (g) Welding electrodes, by and large have a limited shelf life and as such their procurement and issues are required in such a manner to avoid losses.

1.6.13 Refractory/Insulation materials (indoor)

- (a) Powder bags and special bricks should not be exposed to rain/water or damp conditions and kept under closed room.

- (b) When bricks are stored one over the other, it shall be ensured that height of bricks does not exceed the limit to extend of causing damages to the bricks at lower (Maximum height shall not exceed 4 times of the square side of the base).
- (c) Stacking shall be done crisscross so as to avoid falling down of the bricks.
- (d) While stacking the bags, the height should be restricted to avoid damage to bags forming lower level (maximum 10-bag height).
- (e) Pourable insulation bags are always to be stored in a dry place.
- (f) Mineral wool mattresses to be kept above ground and stacking shall not be more than 2 meter high.
- (g) Refractory bricks can be kept in semi- covered sheds.

1.6.14 Resins:

- (a) Resins to be stored in plastic drums, which shall be stored under shade.
- (b) Always maintain moisture in resin- For cation resin add normal clean water and for anion resin add DM water
- (c) Once in a month rotate the drums up and down.
- (d) Once in a year change the water.

CHAPTER-2 MATERIALS HANDLING

2. MATERIALS HANDLING

2.1. Materials handling are preparation, placing and positioning of materials to facilitate their movement for storage. Some statistics of material handling as per the Anglo American Productive Report are as under:

- Materials handling do not add to the value of product but it adds to the cost of the products.
- Materials handling accounts on an average for 36% of production cost.
- Nearly 50 to 100 MT of materials are handled and re-handled for every one MT of finished products.
- About 20-80% of total labour cost goes to labour used in handling.
- About 2/3 of manufacturing cycle time is spent on handling.
- About 40% of industrial accidents are in handling.

2.2. Principles of materials handling

2.2.1 Principle of planning:

Do not leave materials handling to chance- plan handling before they occur- for example:

- a) Avoid placing the materials on floor.
- b) Plan proper storage.
- c) Try to use as few containers as possible.
- d) Consider sizes, entrance, floor etc before hand
- e) Provide clear instructions.
- f) Plan prompt removal of scrap.

2.2.2 Principle of system

Examine all materials handling as a complete system-Do isolate parts. Materials handling systems are a complete integration of the entire individual handling operations in a plant. This will help to make sure that right goods are available at the right place, at right time and right cost. System approach examines aspects such as:

- a) Consider the basic aims of the project and the total project scope.
- b) Integrating the requirements of different handling areas.
- c) Contingency planning for emergencies.
- d) Giving thought to future needs.

2.2.3. **Materials flow principles:**

Many people maintain that the first step in planning any materials handling is to determine the exact flow and sequence of operations. This flow should be optimized to provide the best path, free of congestion and reduction of handling.

Following are suggestions to improve flow of materials:

- a) Avoid congestion
- b) Remove obstacle if possible (rather than go around item)
- c) Keep handling restrictions in mind.
- d) Avoid backtracking and zigzagging where possible.
- e) Arrange alternative paths where possible, in case of emergencies.
- f) Plan for sufficient working place.
- g) Remove work as soon as possible after it is finished.
- h) Plan for waste removal.
- i) Use the right equipment available for the job.

2.2.4 **Principle of Simplification:**

Always try to reduce, combine or eliminate handling operations.

The questions should be asked.

- a) Is the job necessary?
- b) Are the handling methods too complicated- i.e. is it possible to reduce complexity?
- c) Can we reduce handling?
- d) Can we use fewer containers?
- e) Do we have too much paper work?

2.2.5. **Principle of Gravity:**

- a) Wherever possible use gravity, it is simple and cheap.
- b) Always use gravity roller conveyor rather than powered conveyor, where possible.
- c) Chutes and ramps may be used to maximum advantages.

2.2.6. **Principle of space utilization:**

Make maximum use of available space:

- a) Reduce aisles
- b) Stack higher
- c) Use suitable racks or self- supporting containers to increase height.
- d) Remove redundant stock.
- e) Consider disposable containers
- f) Increase inventory turn over.

2.2.7 Principle of Unit loads:

Increase the size and mass of unit load where possible. The larger the unit load, the lower the operating cost. Unit load may be defined as “ A number of items (or items of bulk materials) arranged such that they/it may be handled (picked up or moved) as single object.

Saving can be made in

- Handling time
- Handling cost
- Handling labour

May include items such as:

- a) Several boxes on a pallet.
- b) Many small items in a bin
- c) A single large and heavy item on a pallet.
- d) Many items inside a container.

Following advantages of unit loads:

- a) Permits handling of large loads.
- b) Reduces handling cost.
- c) Allows faster movement of goods,
- d) Reduces time for loading and unloading.
- e) Reduces packing cost.
- f) Make use of cubic space.
- g) Minimizes time in tracing stray items.
- h) Reduces product damages.
- i) Reduces transportation cost.
- j) Reduces time and expenses of labeling individual items.

Main disadvantages are:

- a) Cost of unit load supports (pallets etc)
- b) Securing of unit loads.
- c) Handling equipment of bigger capacity needed
- d) Increase the mass of supports
- e) Returning empty containers or pallets.

2.2.7.1 Pallets:

Pallets are designed to facilitate mechanical handling by forklift truck and are used for both storage and transportation purposes. This helps unit load movements and their use is steadily increasing. They are not used only within the organization to which they belong but also provided to supplier to make deliveries in unit loads and also sent to customers carrying finished products. Due to these practices a degree of standardization is achieved so that they may be handled without difficulties by suppliers, manufacturers, customers and transport organization all using similar mechanical equipment.

Pallets- load with two decks separated by bearer, blocks or feet or a single deck supported by bearers, blocks or feet constructed with a view to handling by forklift or pallet trucks.

(a) Two ways entry pallets:

A pallet whose bearers permit the entry of fork or finger from two opposite directions only.

(b) Four way entry pallets:

A pallet whose blocks permit the entry of fork or finger from all four directions.

(c) Box pallets

Pallets with or without a lid having a superstructure of at least three fixed, removable or collapsible, vertical sides, solid, slatted or mesh which permits stacking.

(d) Post pallets:

A pallet having a fixed or detachable super-structure of posts to permit stack and with or without rails.

2.2.7.2 Pallets can be made of wood or steel- wooden pallets have the following advantages over those made of steel:

- a) Materials, which are lodged on a wooden pallet, are much less likely to be dislodged when the pallet is lifted or moved.
- b) Pallets themselves are more secure when they are loaded into steel pallet racks because they do not slip easily and they are not so apt to slide off the fork of a truck.
- c) There is less possibility of damage to materials or equipment.
- d) They are cheaper to buy or make and cheaper or easier to repair when damaged.
- e) They require no painting and do not rust.

Steel pallets are necessary only for heavy loads or where there are special conditions such as extraordinary fire risk.

Flat pallets are most convenient for boxed or packed materials whereas box pallets are suitable for storing comparatively small and unpacked items.

2.2.7.3 Containers:

Containers are large unit loads specially designed for handling between countries and transported by sea, rail and road container, greatly reduce handling time as they are, really, large pallets into which items may be loaded. These containers are handled by using special equipment, which are available at sea ports and bigger railway yards.

Advantages

- a) Easy to transfer from sea to land-easy to be unloaded from ships.
- b) Easy to transfer from land to rail wagons or trucks.
- c) Easy to store- to be simply stacked in open area.
- d) Faster and reliable deliveries.
- e) Greater protection of cargo from deterioration, handling losses and pilferage.
- f) Ensures original quality of goods.
- g) Simplification of documentary procedures.
- h) Reduction in cost of cargo handling and ship stay at ports.

With the introduction of split containers- goods of many customers can be transported in one container- this optimizes use of full capacity. The larger the container the cheaper the handling cost.

2.2.7.4 Semi-bulk bins and bags

These are large bags or bins used to hold large amount of liquid or granulated products. A semi-bulk may contain the equivalent of 40 bags of granular products.

Semi-bulk bin or bags are designed to replace the manual handling of bags or drums and to allow handling of one big container using mechanical means. One problem with semi-bulk bin is, they must be returned to the initial user, as they cost great deal of money. Semi-bags are easier to return as they fold up for return journey. Semi-bulk bins are extremely useful for in-plant use i.e. where products are moved around factory.

Advantages of Semi-bulk

- a) Saving on smaller bags and drums.
- b) Can handle a large quantity at one time.
- c) Easy to load and unload as unit with mechanical aids.
- d) Easy to stack (on top of each other and thus save space)
- e) Robust and may be stored outside without fearing loss of materials.

Disadvantages:

- a) They are expensive
- b) They are difficult to return.
- c) Bulk bags can be damaged in handling.
- d) Can be handled with mechanical aids only- requirement of such facilities with users essential.

2.2.8 Principle of Safety:

Always make sure that handling system chosen is safe for example ensure that:

- a) Conveyors have guards.
- b) Lifting tackles are load tested and used for right loads.
- c) Hazardous materials are stored in correct containers
- d) Correct equipment is used for the job.
- e) From the radius at which the load is being lifted, the equipment has the capacity.

f) Drivers or operators are properly trained.

2.2.9 Principle of Mechanical and Automation:

Mechanical devices can greatly reduce handling cost. They are less prone of accident in handling but if accidents are there, they are very fatal. Mechanical aids and automation is good when loads are heavy and movements are continuous. As against this, if loads are lighter, manual handling i.e. the natural way is cheaper.

2.2.10 Principle of Equipment selection:

Always try to select best- suited equipment for the required jobs. Suggestions to help select correct equipment:

- a) Determine the exact nature of the job to be done.
- b) Select equipment, which is as versatile as possible.
- c) Standardize as much as possible.
- d) Do not be swayed away by emotions.

A detailed assessment of requirement/selection of equipment can also be made on following lines:

- a) Ascertain the tonnage to be moved now and in foreseen future.
- b) Consider the type of vehicles making deliveries, how their loads are arranged and how they are to be unloaded.
- c) Examine the nature and weight of all the packages and materials to be handled.
- d) Assess the possibilities of using existing equipment
- e) Consider the available storage space and the height, length, width, and layout of building to be used.
- f) Check the arrangements required for stores issue.
- g) Ascertain lifting power, speed, mobility, versatility, size, operating space requirements, purchase price and running costs of various types of handling equipment, which may be thought suitable.
- h) Assess the labour force required.
- i) List any new storage equipment is necessary to employ the machine efficiently (pallets, containers, additional operating attachments).

- j) Make a detailed assessment of both the capital and running costs of any proposed new scheme.

A careful examination of these points will help to select the right equipment.

2.2.11 Principle of standardization:

Standardizing as much as possible on equipment is beneficial because it:

- a) Reduces range of spares to be stored for maintenance.
- b) Allows for better bargaining.
- c) Reduces training requirements.
- d) Allows efficient record keeping.
- e) Allows standard containers and pellets.

However, standardization should not compromise the selection of the right equipment or methods.

2.2.12 Principle of flexibility

Equipment and methods shall be as flexible as possible and should be as far as possible adaptable to changing environment. Examples of flexible systems are:

- a) Four way pallets are more flexible than two ways.
- b) Adjustable racks are more flexible than fixed racks.
- c) Various speed drives allows greater flexibility
- d) Standard lift trucks are often more flexible than specialized equipment.

2.2.13 Principle of Dead Mass

Mobile equipment shall carry as little dead mass as possible. For example, a distribution truck should carry as little excess steel (Tar mass) as possible, suggestions for decreasing dead mass include:

- a) Use steel alloys and aluminum in equipment.
- b) Use of light- weight truck, skids, pallets etc.
- c) Use of right capacity lift truck. It is not necessary to use 5 MT capacity forklift if load is never more than 1 MT.

2.2.14 Principle of motion:

Transport equipment shall be kept moving. Tying up equipment and keeping it stationary should be avoided. Suggestions to keep equipment moving:

- a) Reduce loading and unloading time.
- b) Use mechanical loading and unloading equipment.
- c) Use tractor- trailers to pull load over long time distances- not lift truck.
- d) Avoid down time by correct maintenance.
- e) Plan to haul loads rather than carry them.
- f) Whenever possible use unit loads, those are easy to move.

2.2.15 Principle of idle time:

Reduce idle and unproductive time of all equipment and processors to their minimum. This can be done by ensuring that work takes place i.e. right materials, required equipment and facilities are available and the right incentives are provided.

2.2.16 Principle of Maintenance:

Maintenance should be planned as far as possible i.e. preventive maintenance rather than breakdown maintenance. Maintain all the equipment regularly:

- a) Inspect daily
- b) Train operator
- c) Schedule regular maintenance.
- d) Provide adequate maintenance facilities.
- e) Provide adequate inventories of spares.
- f) Promote pride in equipment
- g) Fix responsibilities.
- h) Follow manufacturers recommendations
- i) Keep all equipment clean.

2.2.17 Principle of obsolescence:

Replace obsolete equipment when the method used becomes outdated and/or inefficient. This is true even for the equipment, which is in good condition.

- a) It also helps to have a proper replacement policy in the organization.
- b) Beware of equipment that “still works”
- c) Hire equipment to test before purchasing.

- d) Keep up with what is new e.g. read magazines, journals, and books and attends lecturers, conferences and exhibitions.

2.2.18 Principle of control:

Use materials handling equipment where possible to provide control in the total production or physical distribution process for example:

- a) Mix materials handling routes.
- b) Mix materials handling lot size and pack size.
- c) Build monitoring and counting features in the equipment.
- d) Try to schedule movements.
- e) Provide for efficient paper work.

2.2.19 Principle of capacity utilization

Use material handling equipment and methods to ensure that all production machinery and distribution facilities are operating at maximum utilization, for example:

- a) Assure uniform feed rate.
- b) Utilize return run of equipment.
- c) Reduce time.
- d) Use area over aisles for storage
- e) Rent facilities in peak season.

2.2.20 Principle of Performance

Determine efficiency of performance i.e. working out cost of handling per a specific unit. This cost then can be compared with total cost or any other information available to find ideal performance monitoring system. Without knowing how well we perform, it is impossible to determine increases or decreases in efficiency, determining performance.

Conclusion:

These principles may be applied to many situations to improve productivity. In many cases these fundamental principles may not apply. The aim of those principles is not a rigid approach to handling but to show methods used by many organizations to improve their material handling techniques.

2.3. Materials handling equipment:

2.3.1 Free path equipment (Continuous movements)

- | | |
|-------------------|--------------------------|
| - Forklift trucks | - Reach trucks |
| - Tractors | - Hand pallet trucks |
| - Sack trucks | - Overhead mobile cranes |

1. Hoists.

Apart from some type of cranes, most free path equipment relies on wheel, which can be split into two categories.

2. Manually operated wheeled vehicles.

3. Powered wheel vehicles.

(a) Manually operated wheeled vehicles:

- | | |
|----------------------------|-------------------------------|
| - Sack trucks | - Trolleys |
| - Mobile stillage trailers | - Dollies -Wheel Barrows |

These equipment are:

- Cheap
- Light and easy to transport
- Some of them can be combined with powered vehicles to improve productivity.

Limitations:

- Limited mass- something less than a MT
- Relatively smooth floor
- Shorter distances
- Small volumes

(b) Powered wheeled vehicles:

- | | |
|--------------------------|-----------------|
| - Power pedestrian truck | - Pallet trucks |
| - Lift trucks | - Reach trucks |
| - Tractors | - Order pickers |

These equipment are very flexible and extensively used in the industries.

(c) Overhead cranes and hoists

- Entry crane
- Winches and Jacks
- Jib crane
- Girder trolleys
- Revolving cranes.

Advantages:

- Highly flexible – may handle a variety of products
- Ranging from small to very high capacity.
- They may handle unusually shaped materials.
- They are not usually dependent on a good floor surface.

Disadvantages:

- They may be expensive
- Maintenance cost is high

2.3.2 Fixed path Equipment (Continuous movements)

- Roller Conveyor
- Pipe lines
- Conveyor Belt
- Overhead mono-frail.

Stacker Cranes

Very useful in handling unit loads and guided by fixed path- in an aisle, in a warehouse. They are alternate to reach, truck- especially high-lift reach trucks. Most suitable in warehouses where high volumes are moved.

Advantages

- a) Very fast.
- b) Work up to a very big height (30 to 40 meters)
- c) High masses can be handled.
- d) They operate on electricity.
- e) Very narrow aisles can be used.
- f) Simple and easy to maintain.
- g) Do not need good floors.

Disadvantages:

- a) They are inflexible
- b) It is difficult to change lane (slow)
- c) They are expensive.

2.3.3 Continuous Path Equipment- Unit Loads

- Gravity Roller Conveyors -Gravity Wheel Conveyors
- Flat Belt Conveyors -Slat conveyors
- Elevators -Chutes

This equipment may rely on gravity or may be powered by a motor through gear-box. Power conveyor is used for higher volumes or where gravity is not available. Their lengths may vary from few meters to several Kilometers. Products are moved quickly, efficiently and in a very high volume.

Disadvantages:

- a) They are fixed and not flexible.
- b) Limited as to size and shape of products to be handled.
- c) They may hinder movement of personnel and other free path equipment.
- d) Often need considerable maintenance.

2.3.4 Continuous Path Equipment- Bulk Handling:

- a) Trough Belt Conveyors
- b) Screw Conveyors
- c) Vibrator Conveyors
- d) Bucket Conveyors.
- e) Chutes

Advantages:

- a) Very high volumes may be processed
- b) Many systems are pollution free.
- c) Limited human involvement
- d) System may be protected for security purposes.
- e) Many systems are highly energy efficient.

The main disadvantage as with all continuous path methods- is inflexibility due to fixed path.

CHAPTER-3
SAFE OPERATIONS-
CAUSES OF ACCIDENT AND
PRECAUTIONS FOR
PREVENTATION

3. Safe Operations, Causes of Accidents and precautions for prevent

3.1. Definition- relating to safety of personnel:

An accident is an unplanned, not necessarily injurious or damaging event, which interrupts the completion of an activity, it is invariably preceded by an unsafe act or unsafe conditions or both or some combination of unsafe act and/or unsafe conditions.

- A personal injury occurs only as a result of an accident
- An accident occurs only as a result of an unsafe action or exposure to an unsafe mechanical or physical conditions or both
- Unsafe action or unsafe mechanical or physical conditions exists only because fault on the part of persons and
- Fault of persons are inherent or acquired from environment and reasons or causes for faults are:
 1. Improper attitude
 2. Lack of knowledge and skill
 3. Physical unsuitability
 4. Improper mechanical or physical environment.

3.2. Unsafe Actions:

- a) Operating without authority-failure to secure or warn
- b) Operating or working at unsafe speed.
- c) Making safety devices inoperative.
- d) Use unsafe equipment, hands instead of equipment, or equipment unsafely.
- e) Unsafe loading, placing, mixing or combining etc.
- f) Taking unsafe positions or posture.
- g) Distracting, teasing, abusing, startling etc.
- h) Working on moving or dangerous equipment.
- i) Failure to use safe attire or personal protective devices.

3.3. Unsafe mechanical or physical conditions:

- a) Inadequately guarded or unguarded.
- b) Defective conditions (rough, sharp, slipping, decayed, corroded, frayed, cracked etc.)

- c) Unsafe design or constructions.
- d) Hazardous arrangements and process etc. (Piling, storage, aisle, space, exits layout, overload, misalignment etc)
- e) Unsafe illumination (inadequate or unsuitable)
- f) Unsafe dress or apparel.
- g) Unsafe methods- processes, planning etc.
- h) Unsafe ventilation.

3.4. Accident Prevention Methods

- a) Engineering revisions
- b) Instruction, Persuasion and appeal.
- c) Personal adjustment
- d) Discipline

Management control

Eliminating Unsafe Conditions	Discovery causes	Eliminating Unsafe actions.
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By means of	By means of	By means of
1. Safeguarding all equipments. Machine, workspace etc.	1. Job safety analysis	1. Personal adjustment
2. Rectify or preventing Defective conditions	2. Investigation of accident	2. Safety education & training
3. Suitable & safe design of constructions	3. Inspection of plant and equipment	3. Supervision
4. Safe arrangement, processes, method of work	4. Recording and tabulation of data	4. Discipline
5. Adequate & suitable Ventilation	5. Analysis of data	
6. Adequate and suitable Illumination		

3.5. The following are some of the precautions, which help in avoiding/minimizing accidents:

3.5.1 Safety in use of lifting Machines and tackles

- 3.5.1** a) Every individual lifting machine shall be marked with individual identification number and safe working load. Machines should be tested periodically.
- b) Cranes with movable jibs or otherwise shall be provided with an automatic load radius indicator clearly visible to operator and if possible fitted with warning bells which ring when the load is in excess.
- c) Where the use of a goods lift is prohibited for carrying persons, there must be a notice on the, lift to this effect.
- d) Control, hands wheels etc on lifting equipment are to be provided with name-plates indicating their functions.
- e) Chain and rope slings, hooks and shackles when purchased, it is to be ensured that they are of tested quality to national or international standards and are duly stamped. They are inspected from time to time and those found defective are scrapped.
- f) For lifting loads rigger must ensure that right type of ropes and shackles are used.
- g) When not in use portable and transportable lifting appliances should be kept in a store under the control of storekeeper. Suitable facilities for hanging items of tackle with proper label shall be developed.
- h) Ensure that the operating staff are using suitable protective viz. hand gloves, goggles, breathing masks, safety helmets, special boots etc. depending upon nature of operation.
- i) There shall be regular preventive maintenance of handling equipment so as to minimize failure during operations.
- j) Always ensure proper housekeeping, avoid scattering of tools, equipment and materials. Many accidents happen due to poor housekeeping.
- k) Always provide dunnage below the load to avoid difficulties in handling.

- l) It shall be the responsibility of the person supervising the lifting operation to ensure that lifting machine or tackle is not overloaded. Equipment operator shall not allow overloading.
- m) When lifts are being taken which necessitate signals to the operator from the ground or intermediate floors, one man shall be detailed by the person supervising the job, and made known to equipment operator, so that he will take signals/instructions from this person only.
- n) A responsible and competent person shall carefully supervise when two cranes are used to lift common load. In this case also only one person shall be authorized to provide instructions/ signal to both operators.
- o) When crane is being operated after long period, the same shall be thoroughly checked before taking into use.

3.5.2 Operating rules for Cranes:

a) Before operating the crane, operator must ensure that

- All guards are in place.
- The limit switches and other electrical and mechanical devices are in proper working condition.
- Gear- boxes are full of lubricants, up to marked optimum level.
- Wire rope is winding on the drum properly and the rope is free from kinks and other defects

(This can be checked by running the pulley block up or down and scanning the rope)

- b) Any defect in the crane such as unusual noise, faulty operation, sparking motors bridge jumping shall be reported to the Engineer/Supervisor for immediate repair before attempting to lift a load.
- c) Movement of mobile crane with loads should be avoided; while operating, boom shall swing slowly and also loads shall be lowered down slowly as per requirement.
- d) The operator should ensure that no one remains in a position of danger in the course of lifting operation.
- e) When loads are being lifted, ensure that slings are balanced to avoid toppling down.
- f) Do not allow anybody to sit on load, when are being loaded or unloaded.

- g) The operator and rigger shall also ensure that the equipment is not overloaded and loads are properly aligned with regard to the strength of slings and their position. Proper arrangements for lifting items like pipes and plates are required to be made. When the weight of the object is in doubt, lifting tackles of higher safe working load capacity shall be used.
- h) Loads shall be raised and lowered smoothly by avoiding jerks due to sudden starts and stops.
- i) Hands and feet shall not be removed from the controls, while a load is suspended.
- j) In case of power failure while operating an electric crane, the controls shall be turned to the “off” position. The area under the suspended load shall be cordoned off.
- k) The operator shall ensure that the hook is directly above the load to be raised and avoid placing an additional strain on the crane and swinging of the load.
- l) Crane shall not be allowed to be used for pushing, dragging or sliding the load
- m) While lowering the block, it shall be ensured that a minimum of two wraps of rope is left on the drum.
- n) When lifting heavy load, the load shall be lifted slightly and tested for wire rope breakage or slings slipping out or brake failure.
- o) When a long sling or hitch is used to lift a load, consideration shall be given to the height of lift so as to prevent tripping of limit switch by the block.
- p) The hoisting rope shall not be used to sling round the materials being handled.
- q) Rope clamps/shackles shall be properly positioned and tightened.
- r) The operator shall not allow the crane to jump against buffers.
- s) The load shall not be left unattended in the air.
- t) Warning bell, gong, whistle or siren shall be used to warn everyone around while operating the crane.
- u) When mobile cranes are working, it shall be ensured not to foul with any pipeline, equipment, structures, and overhead electric line.
- v) A minimum distance of 2 meters shall be maintained between the boom or load and all power lines. In case, it is not possible to maintain this minimum safe clearance for any particular job, the power lines shall be de-energized to avoid any mishaps.

- w) Cable of gantry crane shall not come in contact with water, wet floor/or other moving part of the crane. Cable or any other electrical wire shall not be allowed to lie over or cross over the track and come under the vehicles/cranes.
- x) When the crane is not working, the hooks and slings shall be raised to a height, which will clear all fixed and moving objects below and allow free movement of personnel or vehicle etc.
- y) Before switching “Off” the power from main switch of an electric crane, all controls shall be turned to the “OFF” position.

3.53. Some useful instructions for operating forklift trucks.

(a) NEVER:

- i) Lift the load, which exceeds truck’s maximum capacity shown on the name-plate.
- ii) Tilt the mast forward when carrying maximum capacity, except when over a stack.
- iii) Travel forward with bulky load obscuring your vision- travel in reverse.
- iv) Travel on soft ground.
- v) Carry passenger.
- vi) Block fire-fighting equipment/hydrant valve by parking the truck or the stack the loads in front of this.
- Try to carry out repair, leave this to a qualified maintenance engineer.

(b) ALWAYS:

- i) Follow floor loading limits- find out what is unladen/tare weight of your truck.
- ii) Watch out for overhead obstructions.
- iii) Ensure that load is not wider the width of gangways en-route.
- iv) **When driving on inclines follow these rules:**
 When the load is carried, the load must always be uphill.
 When a load is not carried, the fork must always face downhill, adjust, tilt to suit gradient and raise just enough to clear road.
- v) Travel in a speed consistent with roads and loads conditions.

- vi) Sound the horn and slow down at corners,.
- vii) Avoid sudden stops.
- viii) Travel with fork lowered, maintaining ground clearance.
- ix) Carry out pre-shift checks.
- x) Note the load capacity indicator when fitted.
- xi) Lower loads as soon as they are clear of stack, lower heavy loads slowly, leave your truck with forks lowered fully.
- xii) Remove keys when you leave truck.
- xiii) Authorized driver should operate the truck.

3.5.4. Precautions in use of Wire ropes and wire slings:

- a) Eye splices, sockets and rope anchorage subjected to a direct tensile load shall be capable of withstanding a load equal, at least, to the maximum permissible working load.
- b) Eye splices and loops for the attachment of hook, rings, and other parts to wire ropes shall be provided with suitable thimbles.
- c) The size and maximum safe working load shall be marked on all wire ropes and wire rope slings by means of metal tags or other suitable means.
- d) Ends of wire ropes shall be seized to prevent the strands from becoming loose.
- e) Wire ropes and wire rope slings shall be removed from services whenever their strength is affected by broken wires and 10% or more wires are broken. Corroded, linked rope shall not be used.
- f) In order to keep wire ropes pliable and to prevent rust, the rope shall be lubricated at regular intervals with suitable lubricant free from acid or alkali.
- g) Wire rope slings shall be stored on proper stands at a place free from moisture, excessive heat and corrosive fumes.
- h) Slings shall not be dragged along ground or against rough or sharp objects.
- i) While using the slings kinks, sharp angles or bends shall be avoided. If the object to be handled is having sharp corners, pads of gunny bags or rubber/wooden pieces shall be used.
- j) Where double or multiple slings are used for hoisting purposes, the upper end of the slings shall be connected by means of suitable shackles.

- k) All defective wire ropes and wire slings that show evidence of cuts, abrasion, excessive wear, fatigue or other defects shall be discarded and destroyed.
- l) The factor of safety for lifting tackles shall be at least 6.

3.5.5. Precautions in use of Chains and chain slings:

- a) For the purpose of lifting operations, chain made of iron of less than 19 mm shall not be used.
- b) Chains and chain slings shall not be overloaded beyond its safe working load.
- c) Chains with worn out, damaged or defective links such as lock stretched or jammed or having possibility of welds to open out shall not be used.
- d) Chains and chain slings shall neither be dropped from heights nor dragged from under a load.
- e) While using chain slings over sharp corners, padding of gunny bags, wooden blocks must be inserted as a buffer to protect the chain.
- f) Unauthorized person shall not repair defective chains and chain links, including hammering them to straighten a link or force a link into position. Experienced persons shall carry out all such repairs. After repair and before use, the chain shall be load-tested.
- g) Chain shall not be spliced by inserting a bolt between two links
- h) Chain accessories such as rings, hooks, shackles, sheaves, coupling and end links shall be made of the same metal and shall have same safe working load as the chain to which they are fastened.
- i) Steel chains and their accessories shall be normalized and iron chains and their accessories shall be annealed regularly and tested thereafter for safe working load, which shall be tagged on it.

3.5.6. Precautions in use of Fibre ropes.

- a) Fibre ropes for hoisting, lowering or hauling loads shall be of high-grade manila hemp or equal quality and the factor of safety of such ropes shall not be less than ten. All fibre ropes shall bear a metal tag indicating the maximum permissible load, date of placing in servicing etc.
- b) Eye splices on fibre ropes shall be made round and with suitable thimble.

- c) Ropes shall not be dragged along the ground or on rough surface.
- d) Wet ropes shall not be piled against steam pipes to dry.
- e) Fibre rope shall not be used for hoisting purposes or stored in locations where they will be exposed to contact hot area/objects, acid, alkali or their fumes or other corrosive chemicals.
- f) Sudden pulls or jerks on fibre ropes shall be avoided.
- g) Ropes shall be inspected at frequent intervals while in use and also before placing them in storage and in case they are subjected to any wear or destruction by action of corrosive chemicals and their fumes, those shall be discarded and cut off to avoid their reuse.

Inspection of Fibre ropes:

1. Every rope shall be thoroughly inspected once in 15 days under ordinary conditions and once in a week, if used in critical applications such as to support scaffolding on which men work.
2. Natural fibre and synthetic fibre rope loaded beyond 50% of safe working load shall be discarded and shall not be taken into use again.

3.5.7 Care of fibre ropes.

- a) Precaution shall be taken to maintain the ropes in good conditions and shall not be stored or used in an atmosphere containing acid or fumes.
- b) The recommended factor of safety of fibre ropes for average shall be: Nylon-9, Polyester-9, Manila-5 and Sisal-5.
- c) When lengths of ropes are joined, they shall be suitably spliced and not knotted.
- d) Wet rope or the rope reinforced with metallic strands, shall not be allowed near power lines and other electrical equipment.

3.6 Precautions from fire:

Proper fire-fighting arrangements shall be essential in stores and need to be made in consultation with Fire & Safety Department and Insurance Companies (normally the stocks are insured). Following shall, however, be some of the precautions, which need to be taken care:

- a) Hazardous and non-hazardous goods shall be stored in separate store-houses

- b) Industrial gases shall be stored in proper godown, layout of which shall be as per prevailing regulations.
- c) Oil & lubricants shall be stored separately and such stores shall be built in consultation with oil companies.
- d) Appropriate fire fighting appliances viz. extinguishers, ladders, axes, fire buckets, hoses etc shall be provided in each storehouse and these shall be checked from time to time.
- e) If there is hydrant system that shall be extended to storehouses and open yards.
- f) Smoking in storage buildings and open yards shall be prohibited and notice boards are displayed at appropriate places.
- g) Grass and seasonal tree in open yards shall be cut and disposed off from time to time.
- h) Storehouse and open yards shall be kept clean.
- i) Stores personnel shall be trained for fire- fighting by carrying out necessary drills from time to time
- j) Electrical connections and wiring shall be checked in storehouses from time to time and wherever necessary flame- proof fittings shall be provided.
- k) Procedures for calling fire- fighting personnel shall be thoroughly publicized.

3.7. Safety in manual materials handling

- a) Make a manual handling assessment of your workplace.
 - What sort of loads are moved by whom, and how often?
 - Through what height?
 - Over what distance?
 - Under what conditions?
 - With what assistance?
 - What weights are involved?
- b) Look at accident and sickness records for sign of 'Back trouble' and 'rheumatism'.

- c) Press management to agree a forward program of action and to examine ways of eliminating manual handling altogether by mechanical handling or modifying systems of work to reduce the scale of manual handling.
- d) Determine appropriate weight range for particular manual handling task. Make sure it protect those most at risk, including workers disabled by ill health, pregnant women, young workers etc.
- e) Where loads above agreed limits have to be handled, examine arrangements for:
 - Personnel selection.
 - Training workers in manual handling techniques (especially for itinerant workers).
 - Supervision of manual handling task.
 - Rest period or job rotation
 - Personnel protection.
 - Manning arrangements and provision for assistance with difficult loads.
- f) Also ensure:
 3. Heavy loads are stored at correct height
 4. The weight, contents and center of gravity of heavy loads (including those above agreed action level) are marked.
 5. All work areas are well laid out and adequately lit.
 6. That all means of access and exists are clear and free from obstruction.
 7. Floors and walkways are clean and free from water or oil- insist on non-slip surfaces where necessary.
 8. The use of ladders as a means of maneuvering heavy loads from one level to another is discouraged.
 9. Make sure members understand the need for safe manual handling techniques- examine the need for retraining.
 10. Re-survey your workplace regularly to pinpoint manual handling hazards and review accident and ill health records for sign of manual handling injury.

3.8. Safety in stores operations:

As common with most other industrial operations, safety is a very important matter in store- keeping, and all materials must be stored in such a way to minimize the risk of

injury to staff and damage to goods or equipment. Most accidents occur when movement is taking place, and all such activities should be very carefully undertaken. Even a simple manual lifting operation is potentially harmful and strain will be likely unless the correct 'straight- back knees-bent' method is employed. It may be disturbing to note that approximately 25% of reported injuries in industry result from manual handling.

Safety is everybody's responsibility and not just the manager, supervisor or operator. Each individual as such has to take responsibility for his own safety and the safety of others around him

Some important points for consideration of safe operation of storehouses and their associated equipment are as under:

- (a) Training:** Those working in stores should be made aware of major hazards they may come across at particular location or locations in which they are working. There shall be regular training on safety awareness covering such topics as health and safety rules what to do in the event of an accident. Such programs shall also include the skill of manual handling.
- (b) Housekeeping:** An untidy store is an unsafe store, and an organized approach with properly marked aisles, gangways and walkways kept clear of obstruction, should be taken. Adequate supervision is necessary to prevent untidiness and carelessness
- (c)** Conditions need to be given careful consideration. A requisite working temperature and lighting are important consideration
- (d)** Storage and handling equipment needs to be right for the job, and properly maintained. It must of operated within its designed rating and within manufacturer's instructions and specifications. Periodical checks by qualified personnel are desirable, particularly for high- risk items.
- (e)** Safety equipment/appliances shall be provided and its use shall be insisted upon. In an industrial environment safety helmet and protective footwear and gloves will, typically, be required.

- (f) Safety sign should be used to signal hazards. These come in variety of types and design; examples including no smoking signs in risk area, and sign indicating particular risks associated with individual items.
- (g) Appliances for use in the event of an accident, at the very least a suitable first aid kit, and possibly high volume showers, gas masks should be kept close to stocks of hazardous materials. Emergency communication channels should be available and known to the people working in the areas.
- (h) Suitable guide-lines containing details as how to handle various types of materials, principles of storage and stacking, protective clothing and its use, first aid, health and hygiene shall be developed and issued to the people working in stores.

3.9 Cost of accidents:

If the injured person is not covered under benefit scheme of management for any insurance, he may have to bear himself loss of wages, cost of medical expenses and loss due to partial or permanent disablement. Even if compensation from management or insurance is available, no costing can be done to work out cost of sufferings, pain, worry and effect due to incapacitation to himself and his family.

3.9.1 Cost to Management:

(a) Direct cost:

- i) Compensation paid to injured person.
- i) Medical expenses on his treatment.

If the proper insurance coverage is there, above direct cost may be born by insurer fully or partially.

(b) Indirect cost

- i) Lost time of injured employee
- ii) Lost time of other employees.
- iii) Lost time of foreman/supervisor/executives
- iv) Cost spent on first aid.

- v) Cost of damages to equipment and materials.
- vi) Incidental cost due to interruption of production.
- Vii) Cost under employee welfare scheme.
- viii) Cost of loss of profit on injured person's productivity.
- ix) Cost of recruiting and training a new person in case of permanent disablement or death.

As per data collected by various agencies indirect costs are 4-6 times more than the direct cost.

3.9.2 Cost to Society:

Industrial accident places a heavy burden on society.

Keeping in view the above, it is prudent on the part of everyone to follow safety rules and create an accident free industrial atmosphere.

CHAPTER-4

STOREHOUSES
&
STOCKYARDS

4. STOREHOUSES AND STOCK YARDS

A proper layout of storehouses and stockyards plays a very important role in their safety and security and also the materials kept there. Their layout has also impact on efficient, safe and effective materials handling and thereby effecting overall efficiency of stores operation. Because of variable requirements of different power stations of the Corporation, it is not possible to make a model for the layout and constructions of storehouses and open yards. Very often there is no option but to accept existing facilities and try to make best use of them. Even if the building of new storehouse is planned, the situation is usually complicated by the existing conditions to some extent. The site may be governed not by what is desirable but what land is available; building may have to be harmonized with the existing buildings, and of course the funds allocated for construction. These provisions as such are confined to highlight some general issues, which are commonly connected with layout and construction of storehouse building and open yards.

4.1. New Stores Building:

The proposed construction of new storehouse is based upon the assumption that there are not unusual restrictions on the site or size of building, and the only financial consideration is to put up structure, which will be reasonably economical in relation to services it is expected to provide. Generally speaking, the bigger the building, the more complicated it will be and the greater the problems of construction and operation.

4.1.1. Large Central Storehouse:

4.1.1.1 In order to determine layout and construction, the following data shall be collected:

- a) The number and location of the outlying units which are to be served
- b) No. of items and anticipated quantities to be held in stock.
- c) The division of anticipated stocks
 - The small items, which can be accommodated in drawers or trays.

- Binnable items
 - Goods, which can best be stored on heavy- duty racks or pallet racks.
 - Heavy or abnormal size of items, which must be placed on floor.
 - Crated, boxed or cartooned stores, which can be stacked without racking.
 - Items, which require special racks and fixture (Vehicle tyres or pipes/tubes)
 - Goods, which have, separate storage facilities (Items like gases in cylinder, Oil and Lubricants in drums, other hazardous goods- Chemicals)
 - Materials, which can be kept in outside yards.
- d) Anticipated number of receipts and issues
- e) What major handling equipment, such as overhead cranes, mobile cranes, pallets /forklift truck shall be used?
- f) How many road vehicle are expected to be unloaded and loaded and at what times?
- g) Modes of transportation- if large numbers of rail consignments are expected, provision needs to be made for private railway siding.
- h) The number of staff to be employed.

4.1.1.2 SITE

Selection of site is another important factor, which affect efficiency/service level of stores and operating cost. Following are some of the points, which must be considered while choosing a site:

- a) Storehouses should be as near as possible to geographical centre of areas to be served or to the biggest stores using unit. Selection of optimum location is an important decision and variety of techniques, including linear programming can be applied.
- b) If road transportation is a major mean of transportation the site must have a good road access. It should not be an area congested with traffic.
- c) In case, rail traffic to be handled, site should be near to railways siding.
- d) In order to avoid water logging during rainy season the site so selected should not be a low level, it should be well drained and should not be too far away from services such as power, water, communication.

- e) The site ought to be of sufficient size for its intended purpose, with sufficient space for movement of vehicle and mobile handling equipment, an area for open stockyards and some extra room for future expansion.
- f) The intended site should not be prime land area to keep down investments.

4.1.1.3 Construction:

When the site has been chosen, the next steps are to determine size, shape and construction of storehouse. These are very important aspects as buildings so constructed may be in use for many years to come. Any mistake or miscalculation made at the outset may be a source of continuing irritant and inefficiency for a long time.

The building may be single- storey or double- storey.

The advantages of single storey are:

- a) The cost of per cubic meter of storage area is usually much cheaper because shell can be of lighter construction than the building having upper floor.
- b) The weight carrying capacity of an upper floor is always limited due to structural consideration.
- c) The single storey building can be extended quite easily.
- d) Materials handling costs are less than multi-storey buildings where materials need to be handled up and down.
- e) More use can be made of natural day light
- f) Adequate ventilation is easier to arrange.
- g) Modern high- rise equipment enables the efficient use of vertical space from a single ground floor.
- h) Fire risk is less and fire fighting is easier.

The use of multi-storey buildings may be more favourable in special circumstances such as:

- a) Stores are required to serve production or process shops already operating in multi-storey buildings.

- b) Land available is too less or very costly.

4.1.1.4 Some special consideration for layout and design of buildings:

- a) Lay-out design of building for storage building of oil and lubricants as well as fuel storage/delivery shall be determined keeping in view the Government Regulation and in consultation with petroleum companies.
- b) Similarly, layout and design of storage building for industrial gases in cylinder shall be determined in accordance with requirement of Department of Explosive as their approval/licence is required to be obtained for storage of gases.

Both the above stores are separated from other storage area due to hazardous nature of the products.

4.1.1.5 FLOORS

Floor is very important feature of any storehouse building in view of weight of materials to be stored and requirement of movement of manual as well as mechanical handling equipment. The floor, therefore, must be of adequate strength and have a good, hard, smooth finish with minimum of obstructions. As a first step, it has to be decided whether the floor is to be at ground level or not which largely depends on handling methods. Where the overhead cranes or mobile jib cranes are used for loading and unloading, floor is at best at ground level as these machines unload/load the things from above and the height of lorry or truck platform, the raised floor is of no consequences. On the other hand, fork- lifts are in operation, it may be advantageous to have the floor level raised to height of the road or rail vehicles so that they can be loaded and unloaded with minimum lifting. Where the level is raised above the ground, it is necessary to provide one or more ramps from the ground to floor level of gradient and width adequate to allow access to the storehouse for any vehicle such as forklift truck, tractor or hand trolleys. Flooring of the ramps has to be a little round and rough to avoid skidding of this equipment.

The next step is to calculate anticipated floor loading and design the foundations and floor accordingly. The floor should have a non-slip surface and may be treated with special compounds for dust prevention to minimize problem of keeping stock clean from dust and

grit. The floor of storehouse meant for storage be slightly slanting so that oil spillage if any, is easily traceable.

4.1.1.6 STRUCTURE:

The design and frame work of structure depends upon whether the building is to bear its own weight or is expected to carry overhead cranes, conveyors or mono-rails, their carrying capacity and tare weight. With overhead cranes, a minimum height to the eaves of about eight meters is necessary to allow sufficient room for stacking materials underneath the level of crane hook. The supporting structure also need to be strong enough to carry both crane and its maximum load. For the store-houses not employing overhead lifting devices, the height of the building shall be sufficient to permit the use of double-tier storage racks (These days even three-tier storage racks are in use and the height of the building has to be designed keeping in view the provision of suitable storage racks) The question of height is worth considering carefully as design of racking arrangements subsequently depends on this aspect and the height initially can be increased by a few meters without a proportionate increase in overall costs. If this aspect is not taken care, multi-tier shelving may not be possible later.

The most suitable building materials should be used. Bricks wall are best at floor level to avoid accidental damages from vehicles and equipment but most of the side and roof can be clad with corrugated steel or other sheeting. Use of transparent sheets for roofing at some selected places is advisable for passage of natural light. Durable sealing arrangements are also very important when roofing is done with sheets, as spillage of rain water shall spoil the storage racks and goods stored there, apart from problems of house-keeping.

In order to cope with changing requirements, storehouse layout shall be flexible and permanent internal partitions should be avoided for this reason.

4.1.1.7 STOREHOUSE DOORS

While selecting number and type of doors for a storehouse the following factors must be kept into consideration:

- a) There shall be minimum possible doors to meet requirements of efficient and safe operation of stores with proper and secure locking arrangements.
- b) The height and width of the door shall be sufficient to admit all vehicles and handling equipment.
- c) There shall be separate provision of entries for incoming (receipt) and outgoing (issues) materials.
- d) Alongside the main bigger door there shall be provision for a small door so that employee can have easy access during time when it is not necessary to have main door opened.
- e) The problem with large doors is that the water may drive underneath if heavy rains are there. This can be prevented if the bottom is not flush with the floor but slightly below the floor level and suitable drainage is provided.

COMMON TYPES OF DOORS INCLUDE:

(i) Sliding Doors:

They are simply constructed of GCI or flat galvanized sheet on a welded steel framework and can be either bottom rolling or top hung, in one or more sections and they normally incorporate a pedestrian-pass door. Top-hung doors should have a channel set into the underside of the door, which runs over a bottom guide fixed to the floor at the side of the opening. This is a better arrangement than having a raised guide set in the floor; this raised strip can damage tyres and trip people down. A disadvantage of sliding door is that walls have to be kept clear to accept the doors when they are open. They can, however, be designed to slide into an opening between double walls.

Locks can be floor bolt (monkey-rail bolts), hasps and pad locks. Power driven doors operated by push-button or electronic beams are more sophisticated, more secure and more expensive.

(ii) Roller shutter doors:

These are the doors, which roll up, out of the way and allow an unobstructed passage through the opening. They are designed to close into a channel at the base to seal of draught. It is, however, advisable to keep to rolling channel inside the building to save it from rain- water and for the purpose of security. Normally made of steel, they are heavy and slow to open unless powered by electric motor.

The disadvantage with these types of doors is that they need regular maintenance and frequent defects develop, which make it difficult to open and close. There are also difficulties to lock them securely from outside.

(iii) Sliding folding doors:

These are more sophisticated and expensive version of the sliding doors. These doors, which fold, just need little space for opening and can be partially opened to allow people or vehicle through. They are relatively light to handle and can also be operated automatically. If the end leaf is fixed, they can be locked with sliding door lock or hasp or with a pad-lock. If the end leaf swings, a standard mortise lock and floor bolt can do this job.

(iv) Hinged Doors:

These are traditional type of doors and take up a lot of floor space. Whether single or double-leaf, they are unsuitable for the passing of heavy traffic.

4.1.1.8 Window and Ventilation:

Warehouses need windows as much for ventilation as for light. All windows and ventilation must be secure, wrought iron bar or cast iron frame set in the masonry will keep out intruders and should have additional protection in form of burglar bars or wire-mesh.

4.1.1.9 Receipt and Despatch Docks:

There shall be a Receipt Dock and Dispatch Dock with facilities for loading and unloading.

4.1.1.10 Issue-Bay/Counter:

In order to minimize entries to storage areas of people from user departments, there shall be provision of Issue-bay/Counter.

4.1.1.11 Provision of Stores Shelving

For the optimum utilization of available covered accommodation (Vertical space utilization) and proper warehousing, provision of shelving in store is a very important aspect. It is preferable to go for multi-tier shelving system. While designing the shelving (Preferably adjustable steel shelving) provision shall be made for storage of heavy items and items of

larger dimensions. Design of shelving shall be developed in consultation with manufacturers of slotted angle storage racks.

4.1.1.12 Office:

Suitable office or enclosure should be provided adjacent to Receipt/ Despatch Docks and Issue Counter for the staff working in stores. Portable construction materials need to be used for these types of offices as it may be necessary to change their location in future to cope up with unforeseen circumstances. However, provision of a separate Administrative Block for store is essential for supporting staff, senior officials and record keeping.

4.1.1.13 Lighting

The fullest possible advantage shall be taken for natural light. Sufficient windows and ventilation give the best and cheapest light. In most store- houses, racks are placed along the wall and therefore side windows should be at such a height that these fixtures do not obscure the light from them. Fluorescent tubes are most often used to provide artificial light. The installation ought to be designed in accordance with binning and racking so that maximum amount of light shines into storage compartments both on ground or mid-shelf and the lighting fittings are not in the way of handling equipment. Loading and unloading docks should also be well lit, probably with spotlights or wall fittings. In case of multi-tier racking arrangements, cabling has to be done through PVC conduit pipe for the safety of personnel.

4.1.1.14 Provision for Hot Room & Cold Room:

There may be items (electronic components), which need to be stored in dust free, cold atmosphere to avoid deterioration. For storage of such spares, provisions need to be made for a Cold Room. There may be some items, which may deteriorate due to humidity (items like electrodes and motor- windings) and provisions need to be made for a room, fitted with de-humidifier unit.

4.1.1.15 Fire Risk:

While determining lay- out and construction plan of store- house, it is to be ensured that these take account of the possibility of fire and where the materials in stores present an exceptional risk, it is advised to avoid use of timber in construction, as far as possible, and

cladding which have been treated with bituminous compound or any other inflammable mixture. Heat resistance sheets shall be used. Water main providing an adequate supply should be located in a suitable position and provided with sufficient hydrant and if feasible an overhead sprinkler system should be provided. It may also be worthwhile to provide fire alarm system in the store- houses.

4.1.1.16 Ancillary services:

When the major store- house is being designed, the lay- out and construction should include the following ancillary services:

- a) Toilets and cloakroom room facilities.
- b) Canteen facilities
- c) Parking space for cars and two wheelers
- d) Parking space for materials handling equipment.

4.1.1.17 Extensions:

As far as circumstances allow, the site and construction of new store- houses so planned so as to make reasonable provision for the possibility of extension to cope with changing requirements.

4.1.2. Store- houses serving one plant or operating unit:

For determining layout and construction of this type of stores, many features are similar to those applicable to large central stores, as above. However, following are some additional issues, which need to be considered for store- houses serving one plant or operating unit.

4.1.2.1 Site:

The size of store- house depends partly on the bulk and nature of goods involved, the transport facilities and the plant layout. If the bulk of the goods are received by rail transport, the stores should be located near the rail line and main road. As far as possible stores should be at a central place of various user departments or as near as possible to the department it serves most as to minimize handling and in- plant transportation costs.

4.1.2.2 Construction:

The type of construction of the stores building may have to conform, to the general design of other adjacent buildings.

4.1.2.3 Mezzanine Floors:

Where availability of horizontal space is limited but vertical space is available, the use of mezzanine can be a cost-effective approach to the provision of storage accommodation. A mezzanine can effectively increase storage space to two three times of available floor space.

4.2. Stock- yards

It is expensive to construct building and provide covered accommodation for all type of materials. Certain heavy and less perishable materials can be kept in open yards for a reasonable length of time without any deterioration. Some such material, if need to protect from atmospheric conditions, may be covered with tarpaulins. It is therefore important that proper layout of open yards is considered while planning for store- houses.

However, most of the time, stock- yards receive less attention than the store- house themselves resulting in inadequate and casual arrangements. The following are some of the deficiency noticed at outside storage facilities.

- a) Stocks are scattered over a wide area, making proper control and location system very difficult.
- b) The absence of proper fencing or compound wall increases the risk of theft or unauthorized issues.
- c) Inadequate proper access to stock slow downs transportation and hinders use of mechanical handling equipments. This results in excessive employment of manual labour.
- d) Badly drained surfaces frequently become water logged, causing undue deterioration of stock and making access very difficult during rainy season.
- e) Lacks of proper artificial lighting arrangement make security measures difficult at night hours and also night work impractical and unsafe.

- f) Materials are stacked on the bare earth and, in course of time, become overgrown by grass and seasonal trees or corroded.

4.2.1. If significant stocks are required to be kept in open, it is imperative to design, construct and operate a proper yard, which shall be advantageous in the following ways:

- a) Good planning saves space, which may be very precious.
- b) A proper lay- out with fenced/walled enclosure improves security.
- c) A properly constructed stock- yard with adequate drainage facilitates movement in the yard, avoids deterioration of materials and eliminates growth of grass and seasonal trees.
- d) When goods are properly stacked and labeled, Issues are more convenient and stock-taking is easier and accurate.
- e) Satisfactory rail and/or road access speeds up the turn- round of vehicles.
- f) An efficient lay- out permits the use of modern handling methods, which in turn produces significant economies in deployment of labour and also facilitates faster operations.
- g) If a gate- house and a Weighbridge are provided at the open yards there is much more satisfactory control over the vehicles coming for delivery or collection.

4.2.2. Construction of Stockyards:

4.2.2.1 SITE

The location of stockyard is determined by the disposition of road and rail facilities and the position of existing buildings. Subject to these considerations, the stockyard should be immediately adjacent to main store- house and adequate and unhindered road access. The site should be well leveled and drained.

4.2.2.2 SURFACE

The nature of surface greatly depends upon type of materials to be stacked at the stockyard, transport and handling equipment to be used and atmospheric conditions. Four types of surfaces, commonly in use, are as follow, the depth of foundation and finish being varied to suit local circumstances.

a) **ASHES**

A bed of consolidated clinkers or ashes finished off with fine ashes and rolled. This is one of the cheapest methods but load- bearing capacity of surface is low and is easily cut up by heavy transport. If heavy rains are there, the area becomes slushy and movement becomes difficult. This is unsuitable for fork- lift trucks.

b) **WBM (Water bound macadam)**

Such surface is made of a layer of stone with small quantity of fine, some passes of roller with spray of water. This type of surface has better strength than ash surface. It is, however, noticed that in due course of time grass and other seasonal trees grow especially during rainy season. Due to movement of heavy handling equipments such surface is also damaged.

c) **Tarmac**

A bed of hard-core, rolled and consolidated, covered with a layer of tarmac and finished off with a cast of fine tarmac, rolled. Although it cost substantially more than the above two surfaces, but is much more satisfactory. Drainage of water is more effective; load-bearing capacity is higher- stand up to traffic and easier to keep area clean and possibility of grass and seasonal trees is ruled out. One limitation is that very heavy stocks of materials may tend to damage the surface particularly in hot weather.

d) **Concrete**

A bed of hard-core rolled and consolidated, topped by a layer of concrete reinforced by steel fabric. The cost of this is much higher than the above three types of surfaces, but this is probably the best finish for normal purposes. It drains well, provides an excellent foundation for stocking materials, problems of vegetation and corrosion of materials are overcome, will bear all types of reasonable traffic movement in yards, cleaning very easy and of course less maintenance cost in course of time as compared to other surfaces.

In most of the open yards, access road and gangway occupy substantial area, sometime more than half and it is worthwhile to economize on initial cost by compromising whereby roads are concrete or tarmac and stocking area are of ashes or WBM.

4.2.2.3 Lighting:

There shall be provision of sufficient lighting arrangements to facilitate late hours issues and security requirements. Tower mounted flood- lights may be very useful for these purposes.

4.2.2.4 Fencing and Gates:

Proper fencing with minimum number of gates with locking facilities for a stockyard is very important for the purpose of good physical control and security. Many kinds of fencing are available. The most popular arrangements are using steel or concrete posts, cranked to carry sufficient strands of barbed wire up to a suitable height giving protection against trespassers.

4.2.2.5 Roads and Gangways:

These should be of concrete or tarmac as far as funds permit. The width must be appropriate to the vehicles and load carried and the detailed arrangement of roads and gangways depends on the type of mechanical handling equipments to be used.

4.2.2.6 Stacking Area:

Mechanical handling equipments in use govern the layout of stacking areas in the same way as it affects the arrangements of road and gangways. Stacking area should be clearly defined and roads and gangways shall be kept clear for safe movement of vehicles and handling equipments.

4.2.2.7 Gatehouse and Weighbridge:

In order to supervise coming and going of vehicles and to prevent unauthorized entry to the yard, it is desirable to have a gatehouse, which is frequently combined with a suitable size and capacity of Weighbridge for recording gross and tare weight of vehicles, if required.