Safety At Work

Prepared By: Welding Deptt.

AMANTECH

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1.1 - EMPLOYER'S RESPONSIBILITIES

1.1.1 - SAFE PLACE OF WORK

An employer must ensure that the physical environment of the place of work is adequate. Below are some of the steps an employer should take to ensure a safe working environment.

- Work areas should be large enough to be safe and healthy. This must include general stability, ventilation and fresh air, temperature and lighting.

- Pedestrians and vehicles must be able to circulate safely. Traffic routes, entrances and exits must be kept clear. Floors, walls, ceilings, roofs, doors and gates, loading bays and ramps must be safe.
- Toilet, washing and welfare facilities must be provided. In addition, rest rooms, changing rooms and sanitary facilities, nursing mothers and employees with disabilities must be provided.
- Employees working outdoors should be protected against bad weather, noise, slippery conditions, etc.

1.1.2 SAFE SYSTEM OF WORK

An employer has a duty to provide a safe place of work, which normally means that the 'system' of work provided by the employer must be safe. The provision of a safe system of working is an obligation of the employer, and the employer

remains responsible even if he arranges for an agent to perform this obligation. The employer cannot 'delegate' his duty, and any agent appointed by the employer will be regarded as acting on the employer's behalf. What this means is that if there is an accident at work due to a failure to operate a safe system of work, the employer will be responsible, even if he has asked someone else to run his business on a day-to-day basis. There is no need to prove personal negligence on the part of the employer.

a) <u>Safe Working Methods</u>

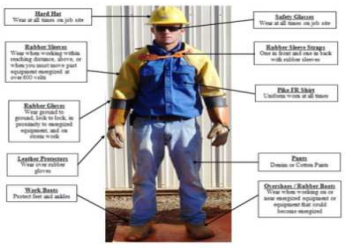
What actually constitutes a 'safe system of work' in any given case very much depends on the kind of work being undertaken. In assessing whether there is a safe system, one must look at the equipment used in the workplace, who it is used by, where it is used, who is likely to be affected by its use, and how each task is carried out. If a blowtorch needs to be used in the workplace, it must be consider whether there are procedures to ensure that those in the vicinity of the blowtorch are adequately protected from it, whether the person using it has been provided with suitable protection, and whether the person using it is properly trained in its use. There are all kinds of factual questions that will arise when deciding whether a safe system of work has been provided.

Something as simple as changing a light bulb in the workplace raises a number of important questions about whether the employer has instituted a safe system of work. Is the employer aware of all the hazards that such a seemingly simple task can entail? For example, is he aware of the risk of electric shock, the danger of falling when the bulb is being changed, the risk of being burnt if the bulb is left on due to inadequate lighting around it, and the risk of the light falling from the ceiling and striking an employee? Has he done anything about these risks? Does he have a system for ensuring that an area can be temporarily lit when a light bulb fuses? Has he provided stable steps or stepladders to be used to reach the bulb? Has he told the employees how to isolate the electricity supply? And can employees carry out their work away from light fittings that might be disturbed and rendered unstable by light bulbs being changed? The employee will of course be expected to exercise a degree of common sense when undertaking the simple task of changing a light bulb, but this example shows how wide-ranging the employer's duty can be. This is not a straightforward area of law.

b) <u>Personal Protective Equipments (PPE)</u>

An employer must provide personal protective equipment (PPE) to the employees. Below are mentioned some of the instructions regarding safe selection and use of PPE.

- PPE must be provided free of charge by the employer and must be used by the employee.
- Wherever possible, employers must eliminate hazards in places of work at source. If these cannot be eliminated totally, they must be reduced to a minimum and adequately controlled.
- The personal protective equipment must comply with any relevant standards. It must be suited to the risks involved, take account of the conditions of the place of work, be suitable to the wearer and for the work to be done.
- Before choosing PPE, an employer must assess its suitability in relation to the risks involved. The employer must also decide on the frequency of use of PPE. This will take into account the seriousness and frequency of the risk.
- PPE must be properly maintained and stored. Normally, only one employee will use any individual piece of personal equipment.
- Employees must be specifically informed of the risks for which the PPE is provided. They must be properly instructed and trained in its use, using demonstrations if appropriate.
- Information, training and consultation on safety and health must take these requirements into account.



1.1.3 SAFE USE OF EQUIPMENT

Following are some of the instructions an employer must follow for safe use of equipment.

- Essential warnings and markings should be placed on work equipment. Employees must be given adequate information and training on its use, including written instructions if these are necessary.
- Repairs, modifications, maintenance or servicing should be carried out only by competent persons. There should be safe means of access for production work and for maintenance or adjustments.
- All equipment must have proper control devices for starting and stopping. Guards should be placed on equipment where there is a risk from contact, or where there are high or very low temperatures.
- Any equipment from which objects might fall must be fitted with safety devices. The containment or extraction of gas, vapour, liquid or dust emissions must be provided for.
- Equipment must be maintained during its working life so that it continues to comply with these requirements.
- New equipment must meet with any Product Directive which applies. Where no Directive exists, the equipment must comply with the requirements set out above.

1.1.4 SAFE WORKING ENVIRONMENT

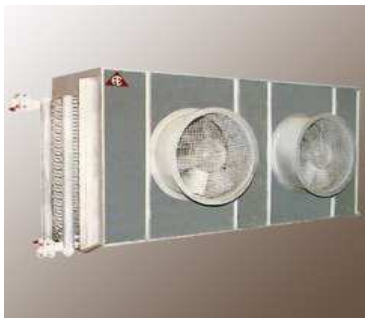
It is the responsibility of the employer to provide safe working environment to its employees. There are several factors that contribute towards the safety of working environment. Some of the main factors are listed below.

a) <u>Workplace Temperature</u>

The Workplace (Health, Safety and Welfare) Regulations 1992 lay down particular requirements for most aspects of the working environment. It states that:

During working hours, the temperature in all workplaces inside buildings shall be reasonable. However, the application of the regulation depends on the nature of the workplace i.e. a bakery, a cold store, an office, a warehouse. The temperature in workrooms should normally be **at least 16 degrees Celsius** unless much of the work involves severe physical effort in which case the temperature should be at least 13 degrees Celsius. These temperatures may not, however, ensure reasonable comfort, depending on other factors such as air movement and relative humidity. Where the temperature in a workroom would otherwise be uncomfortably high, for example because of hot processes or the design of the building, all reasonable steps should be taken to achieve a reasonably comfortable temperature, for example by:

- insulating hot plants or pipes;
- providing air-cooling plant;
- shading windows;
- Sitting workstations away from places subject to radiant heat.



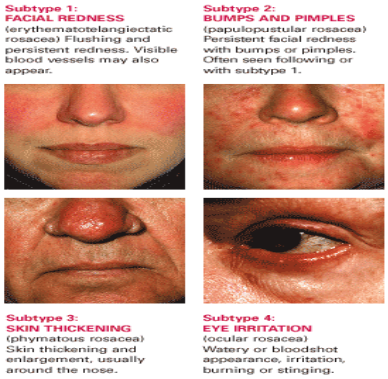
Where a reasonably comfortable temperature cannot be achieved throughout a workroom, local cooling should be provided. In extremely hot weather fans and increased ventilation may be used instead of local cooling.

Where, despite the provision of local cooling, workers are exposed to temperatures which do not give reasonable comfort, suitable protective clothing and rest facilities should be provided. Where practical there should be systems of work (for example, task rotation) to ensure that the length of time for which individual workers are exposed to uncomfortable temperatures is limited.

b) <u>Fumes and Dust Control at Workplace</u>

Although unavoidable in many minerals processing operations, the escape of fumes and dust particles into the workplace atmosphere is undesirable. Excessive fumes and dust emissions can cause both health and industrial problems:

- Health hazards
  - Occupational respiratory diseases
  - Irritation to eyes, ears, nose and throat
  - Irritation to skin
- Risk of dust explosions and fire
- Damage to equipment
- Spoil visibility
- Unpleasant smell



Fumes and dust control is the science of reducing harmful fumes and dust emissions by applying sound engineering principles. Properly designed, maintained, and operated control systems can reduce fumes and dust emissions and, thus workers' exposure to harmful fumes and dusts. It can also reduce equipment wear, maintenance, and downtime; increase visibility; and boost employee morale and productivity.

Dust and fumes removal from the work environment (as required by the Health and Safety in Employment Regulations 1995) requires that all practicable measures shall be taken to ensure that smoke fumes and air contaminants be carried

off and rendered harmless. This will require some furnaces to be well-hooded, with fumes being ducted into a collection system., Dust from dry sand operations such as elevators, shake-outs, shot-blasters, should also be collected and ducted into bag-houses or similar systems. Employers must provide respirators when the air is contaminated with excessive amounts of harmful dust, fumes, mists, gases and vapours.

c) <u>First Aid Facilities at Workplace</u>

The Health and Safety (First-Aid) Regulations 1981 require employers to provide adequate and appropriate equipment, facilities and personnel to ensure their employees receive immediate attention if they are injured or taken ill at work. These Regulations apply to all workplaces including those with less than five employees and to the self-employed.

What is 'adequate and appropriate' will depend on the circumstances in the workplace. This includes whether trained first-aiders are needed, what should be included in a first-aid box and if a first-aid room is required. Employers should carry out an assessment of first-aid needs to determine what to provide. This involves consideration of workplace hazards and risks, the size of the organization and other relevant factors, to determine what first-aid equipment, facilities and personnel should be provided.

d) Other Responsibilities

- Provide your employees a workplace free from recognized hazards that are causing, or are likely to cause, serious injury or death.

  Note: A hazard is recognized if it is commonly known in the employer's industry, or if there is evidence that the employer knew or should have known of the existence of the hazard, or if it can be established that any reasonable person would have recognized the hazard.

- Use work practices, methods, processes, and means that are reasonably adequate to make your workplace safe.
- Do everything reasonably necessary to protect the life and safety of your employees.
- Prohibit employees from entering, or being in, any workplace that is not safe.

- Provide suitable washing facilities and clean drinking water.
- If necessary, provide somewhere for employees to get changed and to store their own clothes.
- Set aside areas for rest breaks and to eat meals.
- Let employees take appropriate rest breaks and their correct holiday entitlement
- Prohibit alcohol and narcotics from your workplace. Prohibit employees under the influence of alcohol or narcotics from the worksite.

  Exemption: Employees who are taking prescription drugs, as directed by a physician or dentist, are exempt from this section, if the employees are not a danger to themselves or other employees.

- Prohibit employees from using tools and equipment that are not safe.

  Note: This applies to all equipment, materials, tools, and machinery whether owned by the employer or another firm or individual.

- Establish, supervise, and enforce rules that lead to a safe and healthy work environment that are effective in practice.
- Consult with employees about health and safety in the workplace .
- Control chemical agents in a manner that they do not present a hazard to your workers.

  Note: Pesticides are considered to be chemical agents. As required by this rule, you must control them or provide protection to workers from exposure to pesticide hazards. Pesticide manufacturers supply precautionary statements in the information provided with the pesticide that tells you how to protect your workers from these hazards.

- Warn employees of equipments, containers, rooms, materials, or any combinations of these that contain viable hazardous agents.
- Provide employees with the information, instruction and training they need to do their job safely and without damaging their health.
- Monitor the work place regularly and keep a record of what is found during the checks.
- Ensure that employees have access to information in appropriate formats, for example, screen reading software, enlarged font, audio etc.
- Provide regular information updates and re-training sessions.

1.1.5 RECORD KEEPING

A record keeping is the practice of maintaining the records of an organization from the time they are created up to their eventual disposal. This may include classifying, storing, securing, and destruction (or in some cases, archival preservation) of records. Each employer shall keep, for at least 3 years, in or about the place of employment, a record of the name, address, and occupation of each employee; the rate of pay of each employee; the amount that is paid each pay period to each employee, and; the hours that each employee works each day and workweek. Good records will keep you on your toes and enable you to monitor every situation. It saves a lot of time and effort and highlights quickly areas where problems could arise and enable remedies to be put in place.

The recordkeeping of injuries and illnesses can be instrumental for safeguarding the safety of the employees. When employers gather sufficient amount of information on injuries and illnesses related to workplace, it will show what kind of patterns exist. Once they identify the pattern, it will be easier for them to take the necessary steps to reduce or eliminate the injuries and illnesses. It is also easier to help employers to concentrate on the occupational hazards with the help of the records. The data collected on the record will help to learn more about the occupational hazards and especially on those which are common across the work site. Employers will be able to analyze and scrutinize the common hazards and do the necessary steps to minimize it.

1.2 - EMPLOYEE'S RESPONSIBILITIES REGARDING SAFETY & HEALTH

1.2.1 - MANAGERS/SUPERVISORS/INSTRUCTORS:

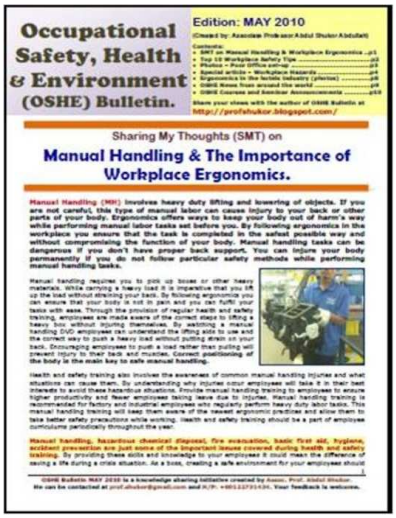
are responsible to provide proper training to the students regarding occupational health and safety.

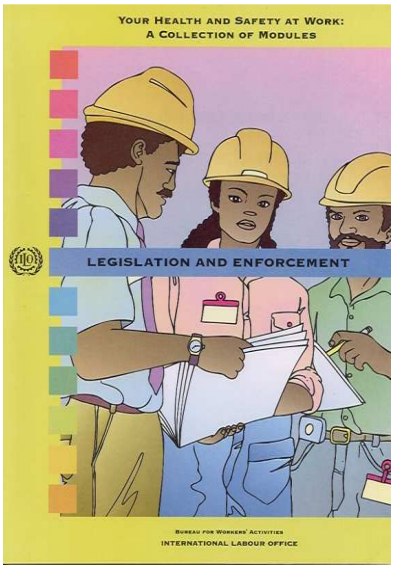
1.2.2 - WORKERS/OPERATORS/STUDENT:

should be fully aware of following safety hazard and analysis its consequences effect on health as well as to avoid any accident which may lead to cause of death. They must take measures to protect himself, others and property from being damaged.

Study of Work Safety Guide:

Before start going to work place it is necessary to study the work safety document related to work.





1.2.3 - HAZARD:

Hazard is a situation that poses a level of threat to life, health, property or environment.

- **Excessive Heat/Cold**
- **Oil Spillage**
- **Confined Work Places**
- **Loose Fitting Clothing**
- **Fumes & Gases**
- **Excessive Noise**
- **Toxic Substance**
- **Radiation**
- **Leakages (Oil, Gas and other leakage)**
- **Electrical Connections and Wiring**
- **Spatters (Grinding/Chipping/welding)**
- **Power Tools/Unguarded Machines.**
- **Failure to use the right Tool**
- **Failure to use tools correctly**
- **Defective Tools**
- **Improper manual Handling**

Excessive Heat: Heat is energy. When you add heat to a substance, *you are adding energy.*

1.2.4 - WHO ARE AT RISK:

- **Outdoors Employee**
- **Welders**
- **Black Smith**
- **Firemen**

Source: Exposure to Sun Heat, Fire Heat ,Environmental Heat, Humidity associated with air

Health Effect:

1. **Heat Cramps**: These are painful spasms usually in the leg and stomach muscles and usually accompanied by heavy sweating.
2. **Heat Exhaustion:** Sweating heavily, Skin may be cool, pale or flushed. weak pulse, Fainting, dizziness, nausea, vomiting, headaches.
3. **Heat Stroke** (also called Sun Stroke)
   This is a severe medical emergency that can result in death
4. **Other Effects** :Heat can also aggravate other conditions such as:

   - Heart disease, especially high blood pressure
   - Kidney disorders
   - Psychiatric disorders

Control:

- **Keep out of the heat**
- **Stay cool**
- **Drink plenty of water**

Oil Spillage

An oil spillage is a release of a any type of oil on the floor road or liquid petroleum hydrocarbon into the environment due to human activity and is form of pollution and provide a chance to slip.

Health Effect:

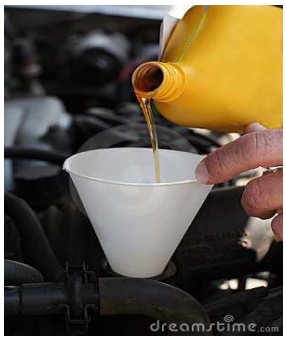
Work place(workshop):

- **Skin rupture**
- **Fractures/ dislocation of body joint.**

Creators (Sea)

Uncultivated soil

Control:



Confined Work Places:

A confined space is a place which is substantially enclosed and where vapors of glues, lacquers, paints, and dust and fumes and welding fumes are produced. This confined place needs adequate arrangement for ventilation and supply of oxygen. Improper ventilation, insufficient lighting.

Ventilation and lack of lighting which may lead to injury and cause of death.

Who are at Risk:

Sand Blaster

Welders

Health Effect:

Control:

Ventilation **Lighting** **Gas detector**

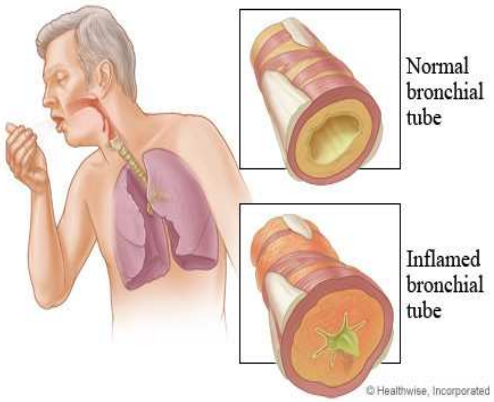
Fumes & Gases:

Fumes and gasses are produced in the result of burning combustible materials.

sources:

Vehicle exhaust emissions

Health Hazard: Acute effect is irritation of the eyes, skin and respiratory tract. Chronic effects include bronchitis, retinitis, fluid in the lungs and pneumonia.



Inflamed or irritated conjunctiva

Control: Ensure Ventilation (Engineering Control), Protect eyes and face with welding shield

Excessive Noise:

Excessive noise often refers to unwanted sound. Sound is a pressure change in the air caused by vibration

Health Effect

- **Hearing Loss**
- **Hearing Impairment**
- **Cardiovascular disease**
- **Hypertension**

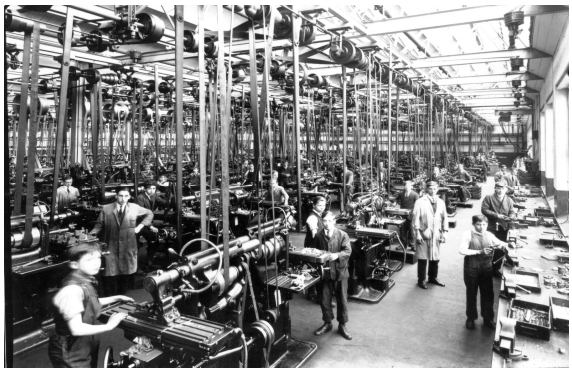
Who are at Risk?

Fabricator/Welder (Hammering, drop forging)

Machinist/Press shop Operator (Pressing or stamping)

Mechanic (pneumatic impact tools, engine sound)

Generator /Compressor Room Operator

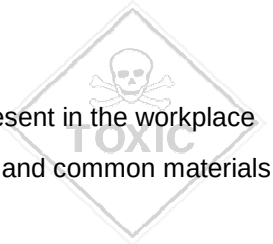


1.2.5 - RESPONSIBILITIES (CONTROL):

Work Practice (Use air plugs)

Engineering Control (Reduce vibration, Air Muffler, and enclosed Working Area)

Toxicity (Toxic Substance): Hazardous and toxic substances are defined as those chemicals present in the workplace which are capable of causing harm. In this definition, the term chemicals includes dusts, mixtures, and common materials such as paints, fuels, and solvents



Source: Paints, fuels, Solvent, Acids and toxic gases (welding fumes and industrial gases) etc.

Health Effect: Skin disease, Eyes problem, Central Nervous System, lung disease, stomach disease.

Responsibility: Use of gloves

Radiation: In physics, radiation describes a process in which energetic particles or waves travel through a medium or space. There are two distinct types of radiation:

Ionizing Radiation:

- X rays
- Gamma rays
- Electrons (beta particles)
- Alpha particles (helium nuclei)

Non-ionizing

- Neutron

Electromagnetic

- Visible light
- Infrared
- Microwave
- Thermal (heat)
- Black Body

The following types of people are considered to be at high risk of heat stress:

Electronic Equipment Operator: (computers,laptops, Cell phone net work operating equipment)

Electric Equipment Operator: (Welder, Power line technicians)

1.3 - HUMAN AND ENVIRONMENTAL CONDITIONS

1.3.1 - CONDITIONS

1.3.2 - HUMAN CAUSES OF ACCIDENTS

1.3.3 - CARELESSNESS

A major cause of accidents in workshops is due to the carelessness of the workers. A high percentage of accidents in workshops are due to carelessness and using the wrong tool. When you are using the wrong tool for a task, you will tend to apply more force than normal. The excessive force may result in slipping or breaking the tool, both could lead to damaging consequences. Always use the right tool for the job.

1.3.4 - IMPROPER BEHAVIOR AND DRESS

There are many causes that can indeed be self injuring or be fatal. The first thing that may be the cause of a workshop accident is wearing the improper equipment. It is important to wear the proper equipment such as safety goggles, a work mask to keep particles out of your lungs. Having the proper equipment helps you to maintain a safe work environment. Secondly loose clothing is also a factor in workshop accidents. For example, if you are working near an open flame or near a cutting device, having loose clothing can increase injury. The clothing can be snagged on a device causing harm.

1.3.5 - LACK OF TRAINING

Not having knowledge and training regarding workshop rules is also a cause of accidents in workshops. You must know the rules when working in a workshop. For example, you must know how to use certain devices. If you do not know then you run the risk of increasing injury. One final reason is because one does not know the workshop procedures. Knowing what to do and in what order is key. If you do something out of order such as using a device in the wrong sequence, then you risk an injury or a fatality.

1.3.6 - SUPERVISION AND EXPERIENCE

Often it is observed that accidents take place when there is no one experienced present in the workshop to supervise the operations. A close monitoring and supervision of all activities in the workshop is essential to avoid serious accidents.

1.3.7 - FATIGUE

Fatigue or exhaustion is also a major cause of accidents in the workshop. Make sure workers do not suffer overtiredness due to work as it will make them prone to accidents and injuries.

1.3.8 - DRUG TAKING AND DRINKING

One of the many serious consequences of drug taking and alcohol is causing accidents at workplace.

1.3.9 - ENVIRONMENTAL CAUSES OF ACCIDENTS

1.3.10 - UNGUARDED OR FAULTY MACHINERY AND TOOLS

Accidents are usually caused when workers tend to roam around or operate on unguarded and faulty machinery respectively which may cause serious injury. Whenever a machine or equipment gets out of order, it should be well guarded or a warning sign should be placed nearby to intimate the workers in the workplace.

1.3.11 - INADEQUATE VENTILATION

Workplaces where fumes or smoke are formed as a result of operation should be properly ventilated so that workers remain safe from the harmful consequences of the fumes which may cause serious damage to the lungs of the workers.

1.3.12 - UNTIDY, DIRTY WORKPLACE

An untidy workplace means potential accidents. Equipments and tools should be placed properly in a tidy manner so that those who are inside the workshop and those visiting should remain safe from tripping over something which may be harmful or become exposed to potential danger.

1.3.13 - OVERCROWDED WORKPLACE

A workplace should never be overcrowded. Crowded workplaces expose the workers to danger in a manner that people can get hurt due to the carelessness of their own colleagues.

1.3.14 - BADLY-LIT WORKPLACE

A lot of accidents take place when workers do not properly recognize the right tool or trip over something due to bad light inside the workshop or workplace.

PREVENTION

1.3.15 - ELIMINATE THE HAZARD

Care should be taken that all potential hazards should be eliminated from the workplace.

Replace the hazards with something less dangerous

When there isn't a chance of completely eliminating a particular hazard, it should be replaced with something less dangerous.

1.3.16 - GUARD THE HAZARD

All hazards should be well guarded and workers should not be exposed to them.

1.3.17 - PERSONAL PROTECTION

Personal protection should be ensured for all workers in a way that it should be mandatory for all workers to wear proper PPE (Personal Protective Equipment) at all times whilst they are inside the workshop.

1.3.18 - SAFETY EDUCATION AND PUBLICITY

Safety trainings should be arranged for all workers and sign boards should be placed everywhere so that safety awareness can be achieved.

	Safety	**Module No.**	1.4
		Prepared by	Ramzan
Course	Certificate in Engineering Skills	**Duration**	30 - Mins
Teaching Aid			
Topic	**Proper Attire**		

1.4 - IMPORTANCE OF PROPER CLOTHING.

- Overalls/ tight dress
- Footwear
- Snood/Cap
- Helmets
- Aprons
- Eye and Face Protection
- Ear Defenders
- Dust masks
- Gloves
- Special Equipment (eg. Respirators if needed)

- Wear oil-free protective clothing made of wool or heavy cotton. Heavier materials work best. They are harder to ignite and resist wear and damage.

- Use steel toe leather boots which prevents you from:
  - Damages caused by falling objects or machined chip on the work floor.
  - Flying Fire sparks/ spatters while welding.
  - Provides you safety against electric shocks.

- During welding wear a helmet with filter lens and cover plate that provides protection from radiant energy, flying sparks, and spatter.

- Always wear dry, hole-free, insulated welding gloves in good condition. They will protect your hands:
  - From burns, sparks, heat, cuts, scratches, and Electric shock at your work.

- Wear a fire-resistant welder's cap or other head covering under your helmet. It will protect your head and hair from flying sparks, spatter, burns, and radiation

- Use ear defenders to prevent from noise.

- Use dust mask to avoid dust to breathe in.

- Use pants without cuffs.

- Use leather apron to double protect yourself from flying sparks and spatters.

1.4.1 - SAFETY WEARING / BELTS FOR ELECTRICIANS.




1.4.2 - SAFETY WEARING FOR WELDERS & MACHINISTS.

1.5 - DANGEROUS ITEMS FOR CLOTHING

- Ties
- Long Sleeves
- Torn Clothing
- Long hair near moving parts of machinery

These types of clothing should be avoided in the workshops, especially when dealing with moving jobs or machine parts, so that it increases the danger to be caught easily by moving parts that may cause any Sevier accident.
For example:

- You are working on a lathe machine wearing tie and casual shirt with long sleeve. Since you have to tilt towards the machine, in that case the tie will be remain straight and it can be engage with the revolving job / continuously forming chips and causes a Sevier accident. Therefore long sleeves and ties should be strictly avoided while working on machines specially for revolving jobs.
- Same as above long hairs also should be avoided, so that long hairs can be turn around the revolving spindle of a drill / milling machine and can hurt you dangerously. Keeping hairs short is a very good habit.

1.6 - PERSONAL PROTECTIVE EQUIPMENT (PPE)

1.6.1 - INTRODUCTION

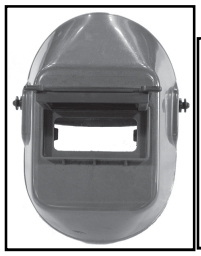
Like other jobs or careers, welders must wear suitable protective equipment. In general, Personal Protective Equipment (PPE) must protect against hazards such as burns, sparks, spatter, electric shock, and radiation.

1.6.2 - GENERAL SHOP SAFETY RULES

Follow the rules.
1) Stay alert.
2) Properly use all tools and other materials.
3) Respond immediately and appropriately to all safety-related incidents.
4) Wear appropriate clothing.

Clothing
Shirts—Wear heavy, long-sleeved shirts with pocket flaps; remove pockets or tape them shut if they do not have pocket flaps; keep collar and sleeves buttoned to keep out sparks.






Pants—Wear pants that have no cuffs and are long enough to cover the top of your shoes or boots.

Welding cap—Wear a cap with a flexible bill that can be slipped around to cover either ear to keep sparks and metal splatter out of the ear opening.

Boots—Wear steel-toed boots made of heavy leather with uppers that reach above the ankle.

Gloves—Wear heavy leather gloves with gauntlets; gauntlets may be short or extend to the shoulder.

Jackets and aprons—Wear leather jackets and aprons for additional protection, especially when welding in confined areas.

Eye protection
Safety glasses—Wear at all times in the welding area; include side protection when flying objects are possible.

Face shield—Wear a face shield, along with safety glasses, when grinding, chipping, cutting, or shaping metal with any type of power tool.

→ If you wear contact lenses, check with your doctor to see if the type of lens you wear requires any special precautions in the work area.

→ If your wear prescription lenses, either wear eye protection that incorporates that prescription into the lens or appropriate eye protection that can be worn over your existing lenses.

→ Select the appropriate lens shade when wearing safety glasses, goggles, or a welding hood.

Welding hoods

→ Stationary filter lens—Contains a fixed lens housing with the shaded lens held in by a spring retainer from where a lens can be slipped out and replaced as welding requires.

→ Flip-front filter lens—Contains lens housing with a front side that can be flipped up so that it leaves a clear-glass lens that permits the hood to be worn while chipping.

→ Auto darkening lens—Used in helmets specifically designed for auto darkening lenses; contains sensors that automatically change the shade from clear to dark in a fraction of a second when you start to weld and gradually changes back to clear when you stop welding; can be manually adjusted for a variety of shades.

1.6.3 - TYPES OF WELDING HAZARDS:

→ Can cause retinal burning and cataracts
→ Proper lenses with the appropriate shading must always be worn

Electric shock:
Two kinds of electric shock: primary voltage shock and secondary voltage shock.

→ Primary voltage shock involves 230 or 460 volts and is caused by touching both the lead inside the welding equipment and the welding equipment case or other grounded metal while the equipment is powered ON.

→ Secondary voltage shock involves 60 to 100 watts and is caused by touching a part of the electrode circuit and the side of the welding circuit.

Do the following to avoid electric shock:
- ➢ Keep dry and wear dry gloves.
- ➢ Stand or lie on plywood, rubber mats or other insulation.
- ➢ Do not rest any part of the body on the work piece.
- ➢ Keep electrodes and electrode holders in good condition.

➢ Do not touch electrodes or metal parts with either the skin or wet clothing.

Fumes and gases:

→ Fumes contain particles from base metal and base metal coating

→ Effects from fumes are normally temporary.

→ Symptoms caused by short-term exposure to fumes can include burning eyes, burning skin, dizziness, nausea, and fever.

→ Long-term exposure to fumes can cause siderosis (which are iron deposits in the lungs) and can affect pulmonary function.

— FUMES —

Name	Source	Effects and Symptoms
Aluminum	Aluminum component of some alloys, such as Inconels, copper, zinc, steel, magnesium, brass and filler materials.	Respiratory irritant.
Beryllium	Hardening agent found in copper, magnesium, aluminum alloys and electrical contacts.	Metal fume fever. A carcinogen. Other chronic effects include damage to the respiratory tract.
Cadmium Oxides	Stainless steel containing cadmium or plated materials, zinc alloy.	Irritation of respiratory system, sore and dry throat, chest pain and breathing difficulty. Chronic effects include kidney damage and emphysema. Suspected carcinogen.
Chromium	Most stainless-steel and high-alloy materials, welding rods. Also used as plating material.	Increased risk of lung cancer. Some individuals may develop skin irritation. Some forms are carcinogens (hexavalent chromium).
Copper	Alloys such as Monel, brass, bronze. Also some welding rods.	Acute effects include irritation of the eyes, nose and throat, nausea and metal fume fever.
Fluorides	Common electrode coating and flux material for both low- and high-alloy steels.	Acute effect is irritation of the eyes, nose and throat. Long-term exposures may result in bone and joint problems. Chronic effects also include excess fluid in the lungs.

— FUMES —

Name	Source	Effects and Symptoms
Iron Oxide	The major contaminant in all iron or steel welding processes.	Siderosis – a benign form of lung disease caused by particles deposited in the lungs. Acute symptoms include irritation of the nose and lungs. Tends to clear up when exposure stops.
Lead	Solder, brass and bronze alloys, primer/coating on steels.	Chronic effects to nervous system, kidneys, digestive system and mental capacity. Can cause lead poisoning.
Manganese	Most welding processes, especially high-tensile steels.	Metal fume fever. Chronic effects may include central nervous system problems.
Molybdenum	Steel alloys, iron, stainless steel, nickel alloys.	Acute effects are eye, nose and throat irritation, and shortness of breath.
Nickel	Stainless steel, Inconel, Monel, Hastelloy and other high-alloy materials, welding rods and plated steel.	Acute effects are irritation of the eyes, nose and throat. Increased cancer risk has been noted in occupations other than welding. Also associated with dermatitis and lung problems.
Vanadium	Some steel alloys, iron, stainless steel, nickel alloys.	Acute effect is irritation of the eyes, skin and respiratory tract. Chronic effects include bronchitis, retinitis, fluid in the lungs and pneumonia.
Zinc Oxides	Galvanized and painted metal.	Metal fume fever.

— GASES —

Name	Source	Effects and Symptoms
Oxygen Deficiency	Welding in confined spaces, and air displacement by shielding gas.	Dizziness, mental confusion, asphyxiation and death.
Ozone	Formed in the welding arc, especially during plasma-arc, MIG and TIG processes	Acute effects include fluid in the lungs and hemorrhaging. Very low concentrations (e.g., one part per million) cause headaches and dryness of the eyes. Chronic effects include significant changes in lung function.

— ORGANIC VAPORS —

Name	Source	Effects and Symptoms
Aldehydes (such as formaldehyde)	Metal coating with binders and pigments. Degreasing solvents.	Irritant to eyes and respiratory tract.
Di-isocyanates	Metal with polyurethane paint.	Eye, nose and throat irritation. High possibility of sensitization, producing asthmatic or other allergic symptoms, even at very low exposures.
Phosgene	Metal with residual degreasing solvents. (Phosgene is formed by reaction of the solvent and welding radiation.)	Severe irritant to eyes, nose and respiratory system. Symptoms may be delayed.
Phosphine	Metal coated with rust inhibitors. (Phosphine is formed by reaction of the rust inhibitor with welding radiation.)	Irritant to eyes and respiratory system, can damage kidneys and other organs.

Machine Guards.

Many accidents are caused by machinery that are improperly guarded or not guarded at all. An important factor that must be kept in mind relative to machinery guarding is that no mechanical motion that threatens a safety should be left without a safeguard.

(1) When a point-of-operation guard cannot be used because of unusual shapes or cuts, jigs or fixtures that provide equal safety for the operator will be used. Upon completion of the unusual operation, the guard will be immediately replaced. Lock-out/Tag-out is required to remove the guard and to re-install the guard after the unusual shape or cut is accomplished.

(2) Whenever a guard is removed for other than an operational requirement, the machine will be shut down and the power control(s) locked and tagged in the "Off" position.

1.6.4 - MECHANICAL HAZARDS:

Moving parts in three basic areas require safeguarding:

· **The point of operation** – that point where work is performed on the material, such as cutting, shaping, boring, or forming of stock.

· **Power transmission equipment** – this equipment includes flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, gears, etc.

· **Other moving parts** – all parts of the equipment that move while the equipment is in operation. These can include reciprocating, rotating, and transverse moving parts, as well as feed mechanisms and auxiliary parts of the equipment.

1.6.5 - NON-MECHANICAL HAZARDS:

All power sources for machines are potential sources of danger. When using electrically powered machines, for instance, the equipment as well as the electrical system itself must be properly guarded and insulated. Compressed air systems and equipment that use compressed air need to properly guarded and secured.

Requirements for Machine Guards:

Machine guards must meet these minimum general requirements:

· **Prevent contact:** The safeguard must prevent hands, arms, and any other part of an individual's body from making contact with moving parts.

· **Secure:** Employees should not be able to easily remove or tamper with the guard. Guards and safety devices should be made of durable material that will withstand the conditions of normal use.

· **Protect from falling objects:** The safeguard should ensure that no objects could fall into moving parts. Even a small tool that is dropped into a press could easily become a projectile that could strike and injure someone.

· **Create no new hazards:** A guard defeats its own purpose if it creates a hazard of its own such as a jagged edge that can cause a laceration. The edges of guards, for instance, should be rolled or bolted in such a way that they eliminate sharp edges.

· **Create no other interference:** Any guard that impedes an employee from performing the job quickly and comfortably might soon be taken off or disregarded. Proper guarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.

· **Allow safe lubrication:** An employee should be able to lubricate equipment without removing any guards. Extending grease fittings around or beyond the guard eliminates the need for the operator to bypass a guard to do the task.

· **Prevent automatic restart:** Where injury to the operator might result if motors were to restart after a power failure, provisions must be made to prevent automatic restart upon power restoration.

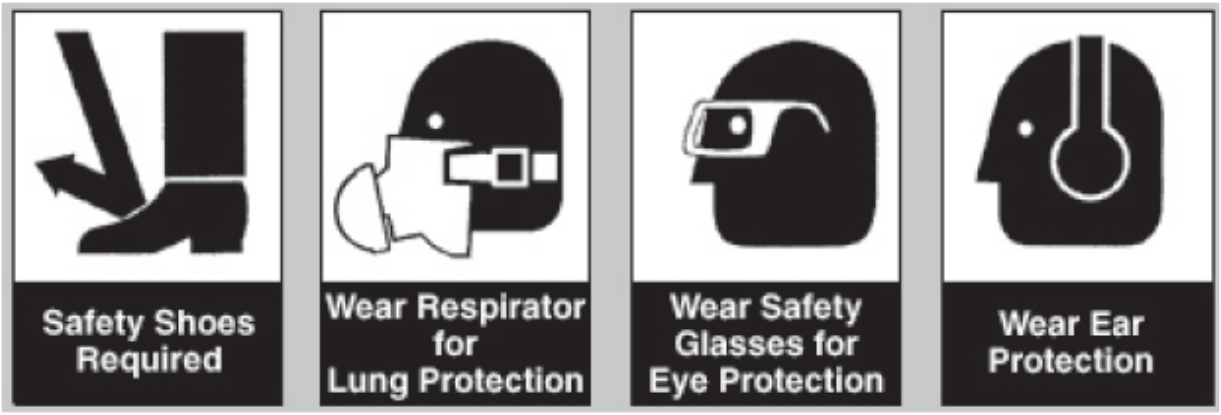
1.6.6 - DEFINITIONS:

· **Guard** - A physical barrier that restricts access to a significant hazard. Various types are listed below:
· **Barrier guard** - closes off access to an area containing hazards.
· **Fixed guard** - securely affixed by fasteners and requiring tool(s) to gain access to a significant hazard.
· **Moveable guard** - does not require tools to gain access to a significant hazard.
· **Nip guard** - a guard (i.e., nip bar, finger bar, finger guard) located at an in-going nip.
· **Two hand tripping device** - Requires concurrent use of both hands to activate the machine.
· **Presence sensing device** - Prohibits activation of the machine until the operator's body or hand tools are clear.
· **Interlocked guard** - Prohibits activation of the machine until the guard is properly installed.
· **Ingoing Nip** - The area created by either two rotating components that are rotating inward, or one rotating toward an adjacent surface.
· **Pinch Point** - Moving part(s) of any point of a machine that creates a hazard for a part of the body to be caught by or between (except point of operation).
· **Point of Operation** - The area of the machine where work is actually performed on the material being processed (i.e., cutting, shaping, or forming).
· **Significant Hazard** - A potential source of severe or disabling injury, or death.

Screens:
Steel Guard Welding Screens help protect persons exposed to welding hazards from small, confined welding areas in MIG, TIG, Plasma or General Welding Areas.

Fences:
Enclosing structure: A structure erected to enclose an area and act as a barrier, especially one made of wood or with posts and wire.

DANGER	**DANGER:** Uses a red background with white lettering to indicate an imminently hazardous situation, which if not avoided, will result in death or serious injury.
WARNING	**WARNING**: Uses an orange background with black lettering to indicate a potentially hazardous situation that could result in death or serious injury.
CAUTION	**CAUTION:** Uses a yellow background with black lettering to indicate a potentially hazardous situation that may result in minor or moderate injury.
EMERGENCY	**EMERGENCY:** Uses a green background with white lettering to identify safety equipment, first aid, or emergency exits.
NOTICE	**NOTICE:** Uses a blue background with white lettering to indicate safety information on signs and bulletin boards.



Stop buttons/isolation devices:

If you stop something happening, you prevent it from happening or prevent it from continuing.

1) Requirements for the safe handling and use of:
a. Machinery (also known as Industrial equipment)
b. Power tools
(1) Electric tools;
(2) Pneumatic tools;
(3) Liquid fuel tools;
(4) Powder-actuated tools; and
(5) Hydraulic power tools.
c. Hand tools

2) Some industrial equipment:
Examples include abrasive wheel equipment (bench) grinder, drill presses, lathes, mills, vertical and horizontal band saws, table saws, radial arm saws, planers, and joiners.

1.6.7 - COMPONENTS

1. Hazard Identification
a. Industrial Equipment. Hazards associated with industrial equipment may include, but not limited to, electrical components, pneumatic components, hydraulic components, points of operation, power transmissions, and auxiliary equipment.

b. Power Tools. Improper use and/or maintenance of power tools may result in injuries such as lacerations, serious cuts, crushing injuries, or electric shock. Employees may also be struck by flying debris/chips/sparks, or caught in nip points or rotating parts.

(1) Electric Tools. The most serious hazards from an improper electric tool can range from electrical burns to shocks to heart failure. An electric shock can also cause other consequences such as causing the user to fall off a ladder or other elevated work surface.

(2) Pneumatic Tools. Pneumatic tools are powered by compressed air and include chippers, drills, hammers, and sanders. The biggest hazard associated with the use of pneumatic tools is the danger of getting hit by one of the tool's attachments or by some kind of fastener the worker is using with the tool. Noise is another hazard associated with pneumatic tools.

(3) Liquid Fuel Tools. Fuel-powered tools are usually operated with gasoline. The most serious hazard associated with the use of fuel-powered tools comes from fuel vapors that can burn or explode and also give off dangerous exhaust fumes.

(4) Powder-Actuated Tools. Powder-actuated tools operate like a loaded gun and must be treated with extreme caution. These tools are highly hazardous and so they must be operated only by specially trained employees.

(5) Hydraulic Power Tools. The hazards associated with hydraulic equipment include exposure to pressurized hydraulic fluid in the event of a hose, valve, pips, filter, or other fitting failure.

Hand Tools.
Hand tools are tools that are powered manually. Hand tools include anything from axes to razor blade knives to wrenches. The greatest hazards posed by hand tools result from misuse, lack of pre-use inspections, and improper maintenance (e.g., If a chisel is used as a screwdriver, the tip of the chisel may break and fly off; If impact tools such as chisels, wedges, or drift pins have mushroomed heads, the heads might shatter on impact). The most common hand tool accidents are caused by the following:

(1) Failure to use the right tool.
(2) Failure to use a tool correctly.
(3) Failure to keep edged tools sharp.
(4) Failure to replace or repair a defective tool.
(5) Failure to store tools safely.
IMPORTANT: Use the right tool to complete a job safely, quickly, and efficiently.

Power Controls
(1) Industrial equipment shall be equipped with an individual disconnect switch that can only be locked in the "off" position.

(2) Install anti-restart (magnetic) devices on industrial equipment where injury to employees might result if motors were to restart after a power failure.

c. Machine Guards. Many accidents are caused by machinery that are improperly guarded or not guarded at all. An important factor that must be kept in mind relative to machinery guarding is that no mechanical motion that threatens a safety should be left without a safeguard.

(1) When a point-of-operation guard cannot be used because of unusual shapes or cuts, jigs or fixtures that provide equal safety for the operator will be used. Upon completion of the unusual operation, the guard will be immediately replaced. Lock-out/Tag-out is required to remove the guard and to re-install the guard after the unusual shape or cut is accomplished.

(2) Whenever a guard is removed for other than an operational requirement, the machine will be shut down and the power control(s) locked and tagged in the "Off" position.

Maintenance
(1) Supervisors shall be responsible for assigning competent personnel to perform preventative maintenance, adjustments, and repairs of industrial equipment. The competent person(s) shall follow the manufacturer's recommendations (i.e. operation and/or maintenance manuals), if available, which establish guidelines for use and care of machines. If the manufacturer’s recommendations (i.e. operation and/or maintenance manuals) are not available, the supervisor and competent person should develop guidelines by using best engineering practices.

(2) Maintenance Area. The area around the machine shall be kept clear of all personnel not directly involved in the maintenance operation.

1.7 - SAFE AND SOUND HANDLING

1.7.1 - CYLINDERS: SAFE STORAGE, HANDLING, AND USE

To use compressed gas cylinders safely, it is important that they are stored properly, handled correctly, used with the correct equipment, and that the properties of the gases they contain are fully understood.

1.7.2 - OVERVIEW OF CYLINDER PHYSICAL HAZARDS

Physical Damage: Cylinders, with their high internal pressure [up to 2,500 pounds per square inch gauge (psig)], are very hazardous when exposed to damage from falling over or tipping, heat, electric circuits, motion, or vibration – anything that can cause a weakness or crack in the cylinder wall or shell. Such damage can cause the cylinder to rupture and explode sending sharp metal pieces, like shrapnel, blasting through the area.

Valve Hazard: The CGA (in Pamphlet V-1) has established a 0.300 inch (7.62 mm) maximum valve inlet diameter as a requirement to minimize the propulsion effect in case the valve is severed. This standard has the exception of valves used in liquefied gas services and fire control systems. Special design requirements an d unique applications such as fire control systems, which require a “high blow down flow”, may dictate greater diameters. The actual outcome of a broken off valve depends on the design and pressure of the valve and cylinder. If the valve is broken off and the valve inlet opening meets the Compressed Gas Association (CGA) requirements, the cylinder will rapidly release all its gas (which could be a health and/or flammability concern), cause a whistling sound, and possibly spin uncontrollably. If the valve inlet opening is different from the standard hole size used in most welding gases, such as those used for propane or butane and fire protection system cylinders, the cylinders may take off and become airborne. You can check this size matter by being sure the cylinder meets all V-1 requirements.

Tipping and Falling: The most common major hazard is having a cylinder tip over or fall on you or another nearby worker. Since cylinders are heavy and awkward to handle, they require special care and equipment in handling and securing so they don’t fall or tip over and cause injury.

Valve Leakage: Cylinder valves can leak, causing their contents to discharge. To minimize hazards from leaks, use proper ventilation and storage.

1.7.3 - OVERVIEW OF CYLINDER CONTENTS HAZARDS

Read, understand, and follow the markings on the cylinder, the label(s) on the cylinder, and the material safety data sheet (MSDS). Each compressed gas cylinder has unique hazards based on contents. Some are filled with inert gases – especially those used in arc welding. Many gases are flammable, explosive, toxic, or a combination. Common compressed gases include acetylene, carbon dioxide, argon, hydrogen, nitrogen, air, propane, and oxygen.

1.7.4 - HOW TO STORE CYLINDERS

• Store cylinders upright and secure them with a chain, strap, or cable to a stationary building support or to a proper cylinder cart to prevent them from tipping or falling.

• Completely close the valves, and keep the valve protection devices, such as caps or guards, securely in place.

• Store cylinders in a dry, well-ventilated area at least 20 feet from combustible materials. Do not keep cylinders in lockers. If they leak, a buildup of flammable or other types of gases can occur inside the locker.

• Mark the storage area with proper precautionary signs, such as flammable, oxidizer, or toxic.

• Place them in a location where they will not be subject to mechanical or physical damage, heat, or electrical circuits to prevent possible explosion or fire. Keep cylinders away from vehicle traffic.

• Store empty cylinders separate from full ones.

• Keep oxygen cylinders 20 feet away from fuel-gas cylinders, such as acetylene, or separate them with a noncombustible barrier (such as a wall) at least 5 feet high with a fire-resistance rating of at least one-half hour.

1.7.5 - HOW TO TRANSPORT CYLINDERS

• Most accidents or injuries involving cylinders happen when moving or handling the gas cylinders.
• Use the right equipment, correct procedures, and sufficient number of persons to lift and move cylinders to avoid personal injury and cylinder damage.
• Wear protective footwear, safety glasses, and heavy gloves.
• Securely install the valve protection devices, such as caps or guards.
• Secure cylinders upright to a proper hand truck or cylinder cart designed for the purpose.
• Don't drag or roll them – use a properly designed cart or hand truck.

• When using a crane, be sure to use proper cradles, nets, boats, or special platforms designed for this purpose to prevent cylinders from falling.
• Prevent damage – handle carefully – avoid dropping or banging them.
• Do not lift by the protective cap/guard or use magnets or slings to lift or move them since valves may be damaged or sheared off.

1.7.6 - HOW TO MAINTAIN THEM

• Protect the markings on cylinders that identify the contents, and mark the full/empty status on cylinders (do not use color to identify contents). Mark all empty cylinders (some companies use "MT").

• Don't use the recessed top of the cylinder as a storage area for tools or material.

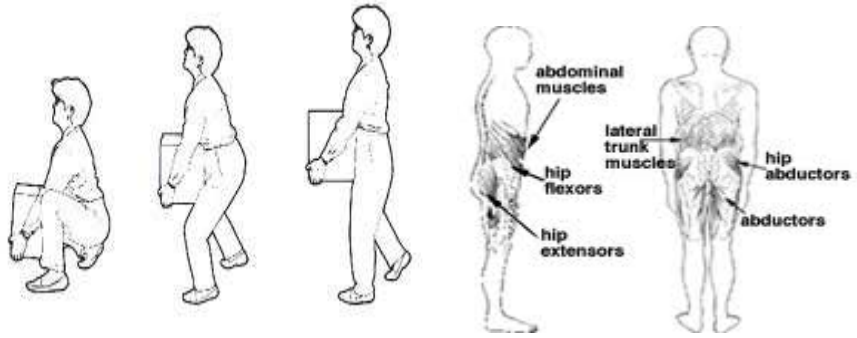
• If cylinders are leaking, isolate them outdoors and away from sparks or heat. Call your gas supplier to send qualified people to take care of the problem – don’t try any repairs yourself. Tag leaking cylinders. • Never mix gases in a cylinder or try to refill a cylinder – always contact your gas supplier.

1.7.7 - WHAT IS GOOD POSTURE?

Good Posture is when your muscles, bones and joints are in the correct alignment, so that muscles are being used properly and to their maximum efficiency, which means not only will you have more power and control, but it also reduces the possibility of headaches and back pain in general, and avoids many other common ailments.

This means that the bones, muscles and the items that connect them all together – the tendons and ligaments – are in their natural and intended positions.

The best posture is always the one in which all body segments are balanced in the position of optimal alignment and maximum support, with full mobility possible.



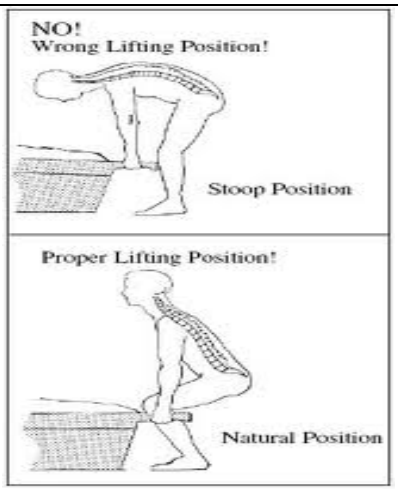
Why is good posture so Important?

Good Posture is important because the Human Body functions best when all its many different parts work in unison – together as one unit. That is the way it was designed to work. When one part is weak or diseased, other parts will be affected that do not even have to be directly adjacent of or connected to that part.

1.7.8 - WHAT ARE THE CORRECT LIFTING AND CARRYING TECHNIQUES?

1 .If you must lift objects, do not try to lift objects that are awkward or are heavier than 30 pounds (say 14 kilos). If you are younger than 16, and female, these weights should be reduced according to your capabilities. Similarly for boys.
2. Before you lift a heavy object, make sure you have a firm footing. Position your feet apart for a stable base.
3. To pick up an object that is lower than the level of your waist, keep your back straight and slightly bowed at the lower back, then bend at your knees and hips with the buttocks moving as directly and vertically downwards as possible. NEVER bend forward at the waist with your knees straight.

4. Stand close to the object you are trying to pick up, bend your knees and use a firm grip and test the weight.
5. Breathe in, tighten your abdominal muscles, bend your hips and knees and exhale as you lift the object using your abdominal and leg muscles, head up.
6. Straighten your knees in a steady motion. Keep the item close to your body.
7. Stand completely upright and do not twist the body whilst holding a heavy object.
8. Don't lean forward whilst carrying a heavy object.



9. If you are lifting an object from a table, slide it to the edge of the table so that you can hold it close to your body. Bend your knees so that you are close to the object. Use your abdominals and legs to lift the object and come to an upright standing position. Exhale on lifting.
10. Avoid lifting heavy objects above waist level.
11. Turn or lead with your feet, not your body.
12. Lower the item using the same technique in reverse order.

1.7.9 - WHAT IS A CROWBAR?

A crowbar or pry bar is a type of tool used to pry objects apart, remove nails, and for general demolition. A crowbar can be found in most construction tool kits because it can be used in a wide variety of applications. Crowbars come in a number of different sizes and weights, depending on how the tool will be used, and some carpenters have more than one so that they can use the right tool for the job.

Most crowbars are made from steel, which is a solid and strong metal that will give the crowbar a long life of use. Other crowbars are made from titanium, which is a lighter metal. Titanium crowbars are also nonmagnetic, which can be very useful on certain construction sites. Crowbars are usually made with materials that will be resistant to bending, which could reduce the effectiveness of the crowbar as a lever. Some crowbars with a curved end replace the wedge with a handle for better grip.

A crowbar is particularly ideal for basic carpentry and roofing. Because the tool is multipurpose, it reduces the number of tools which need to be carried around on the job site, making a tool belt much lighter. On a roof, a crowbar can be used to pry up old shingles, remove rotted beams, and remove nails. For construction, it is also a practical tool, especially when the construction involves demolition. In addition to using the crowbar as a lever, a carpenter can also use the weight of the crowbar to dislodge and break apart obstacles.

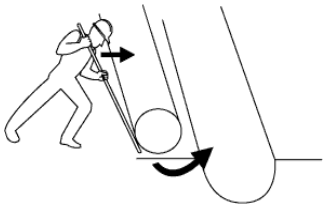
How to Safely Use a Crowbar

The crowbar is used to lever attached items apart and is mostly used for demolition purposes. When using the crowbar in demolition you need to be careful to not injure yourself.
Here are some handy tips to protect yourself and others when you use a crowbar.

1. Be sure to secure the object you are demolishing. Trying to pry apart something that isn't properly secured can result in your just moving the object without the object being pried a part. If excessive force is applied you could end up throwing the object through the air and hitting yourself or others.
2. Check to see if there are any breakables or nails attached before you lever an object apart. Flying glass and board's with nails can cut you and result in injury to others.
3. Always pry with the bar away from yourself. For instance If you are right handed, pry the object so that the object will fall apart to your left. If you are left handed pry to your right.
4. Make sure the area is clear so that if you are prying a part something that can fall or fly through the air you won't hurt other people.
5. Find a narrow crack and insert the pry bar (Of proper length!)Into the crack and then apply force slowly. Never quickly break something apart, especially if you have no idea what is behind it
or inside of it.
6. Apply force by bending the knee away from the object, crouching and pushing down or away from you with your arms SLOWLY! Do not twist or bend your back. You can injure yourself by bending or twisting your back while applying force, especially if the object gives way suddenly. If the object you are levering a part is vertical then apply force with your arms and shoulders,
not your back.
7. Be aware of the weight and structure of your crowbar. A crowbar can only pry apart so much weight. If the crowbar is bending, stop.
In summary, always be sure to wear the proper PPE or personal protection equipment when using a crowbar. Never apply force quickly to an object you are prying apart. And be sure to be
aware of yourself and other people in the room to prevent injury.

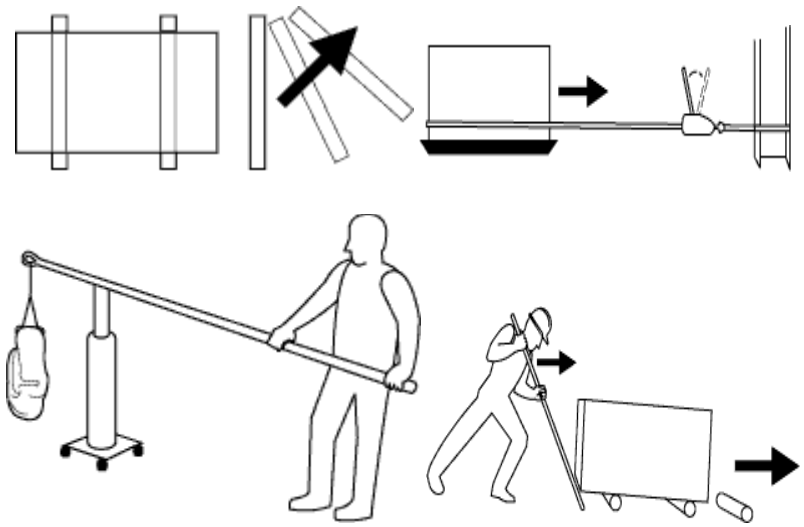
1.7.10 - WHY AND HOW SHOULD LEVERS BE USED?

Using levers reduces the force required to handle materials and avoids bending and stooping.



- Use a steel bar to shift an object horizontally.
- Use the lever and rollers to move a load horizontally.
- Use rollers on an angle to change the direction of the load.
- Use "Come-Along" to move heavy load. Ensure load is fully on the skid to prevent drag or resistance.
- Mount lever on wheels to assist in when moving load. Ensure that wheels can be locked.

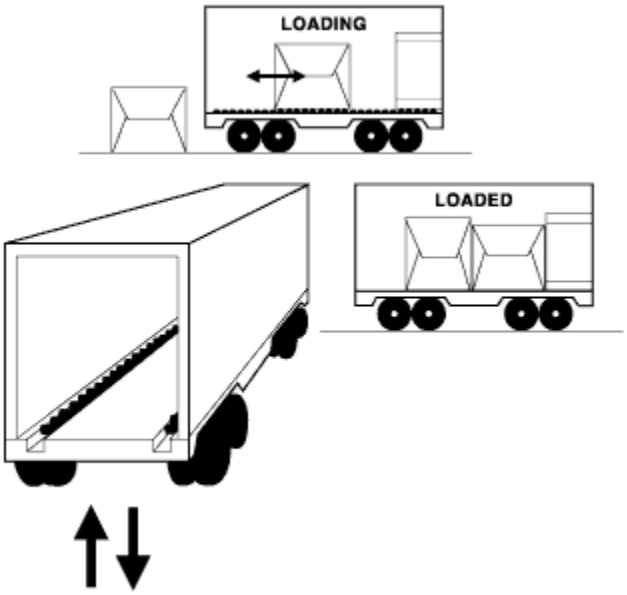
- Lever on a rolling platform lifts and moves objects.
- Lever on wheels lifts and moves manhole covers.
- Use an extended handle to lift, shift or move objects without bending.



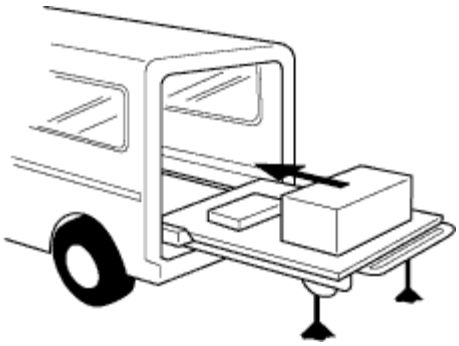
1.8 - SAFETY MEASURES

What can be done to reduce the amount of times material is moved or handled?

- Use rollers to eliminate manual lifting and carrying.
- Use floor rollers while loading or unloading trucks to reduce lifting.

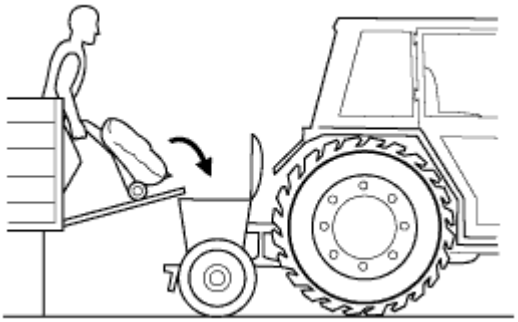


- Use a sliding bed while loading and unloading small trucks to avoid overreaching and carrying in an awkward position.

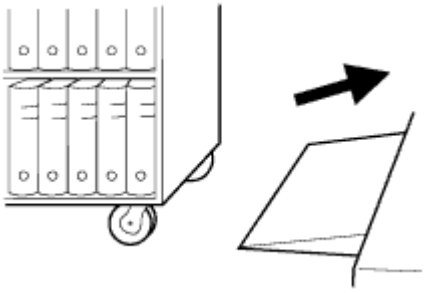


- Eliminate extra loading or unloading steps where possible.

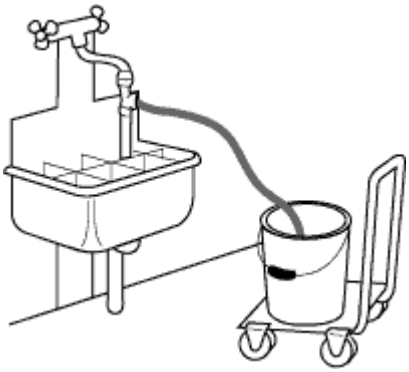
- Unload as close as possible to the place where material will be needed.

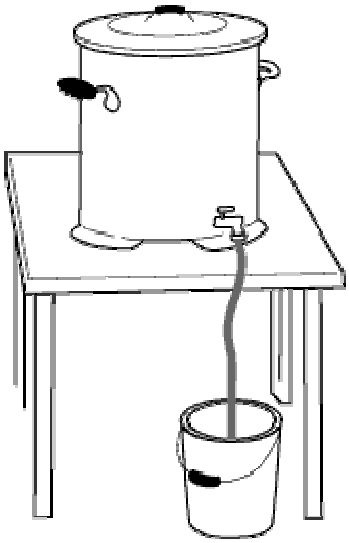


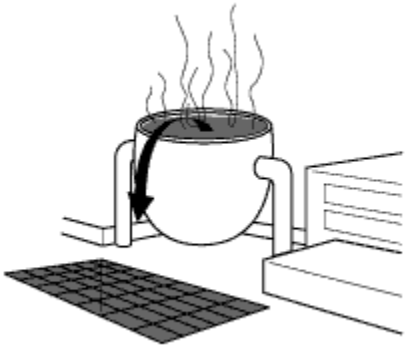
- Use ramps to avoid lifting and dragging over edges.



- Use containers that allow fluids to pour or empty without lifting the container.

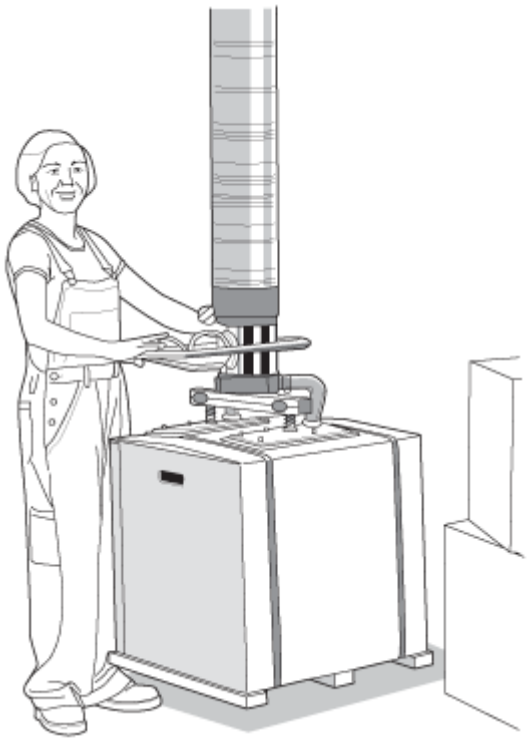






- Use conveyors to link workstations and reduce carrying distance.
- Use a powered stair climber to reduce effort of carrying of loads, and reduce force needed to move loads up and down stairs.

- Use vacuum lift to eliminate manual lifting and carrying of large packages, containers, boxes and barrels.



1.8.1 - WHAT MECHANICAL AIDS CAN BE USED?

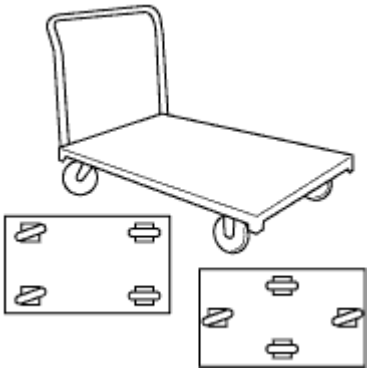
Mechanical aids reduce physical effort, making materials handling easier and safer.

- Check for the availability of mechanical aids before lifting or moving loads.
- Select the right equipment to complete the task.
- Do not operate any equipment if you are not trained to use it.
- Keep the equipment in good and safe operating condition. It saves effort while transporting loads.
- Make sure equipment is maintained properly and inspected regularly.
- Visually inspect the equipment for any defects such as loose wheels or damaged platforms before use.
- Use rolling platforms to assist in carrying and handling heavy objects where limited space does not allow for comfortable body position.

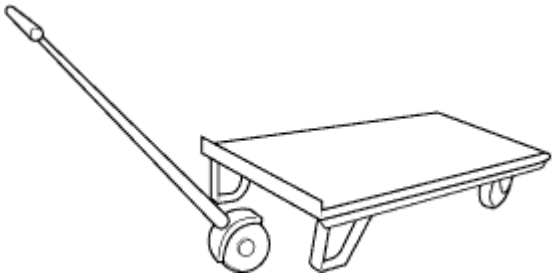
- Use a hand truck to move bulky objects.

- Use a shelf truck to move a variety of objects.

- Use a platform truck to move heavy, irregularly shaped objects.



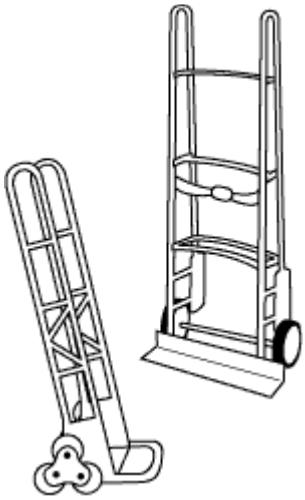
- Use a semi-live skid for temporary storage of work.



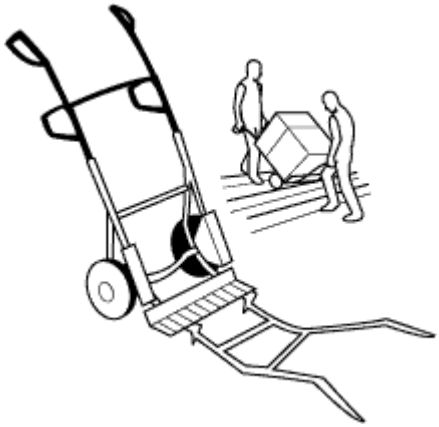
1.8.2 - WHAT OTHER MECHANICAL AIDS CAN USE?

Specific tasks or objects require specialized equipment.

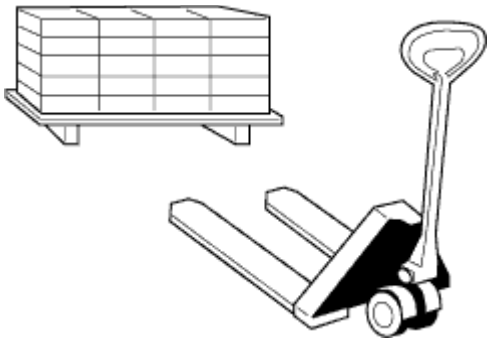
- Select the right equipment to complete the task. Equipment is rated for different capacities, which determine the maximum weight the equipment can safely handle, and the conditions under which it can handle those weights.
- Do not operate any equipment if you are not trained to use that equipment.
- Keep the equipment in good and safe operating condition. It saves effort while transporting loads.
- Visually inspect the equipment for any defects such as loose wheels or damaged platforms before use.
- Be sure that the load is securely in place before moving.
- Always push the equipment rather than pull it.
- Select a stair climbing truck when moving load on stairs.



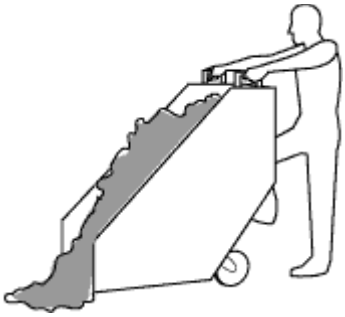
- Choose a sturdy frame hand truck with larger wheels to move materials in rough terrain. Additional set of handles allows for assistance.



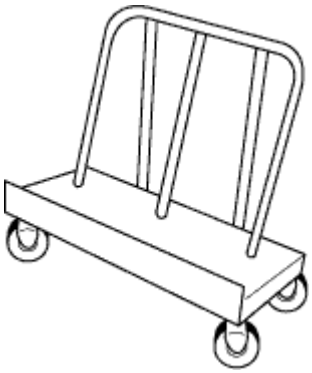
- Use a pump truck to move materials stored on pallets.



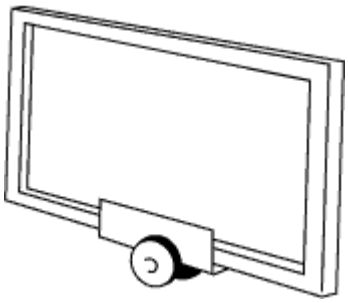
- Move and dump waste materials with dump trucks.



- Handle sheet materials with an "A" frame hand truck or dolly.



- Use a forklift to move heavier and stackable material.

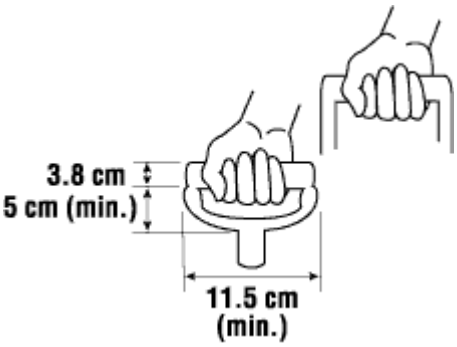


1.8.3 - HANDHOLDS ON LOAD AND GRIPPING AIDS

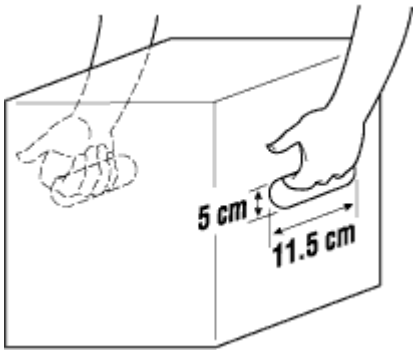
Does a good grip matter?

Yes. Good handholds make lifting and carrying easier and safer.

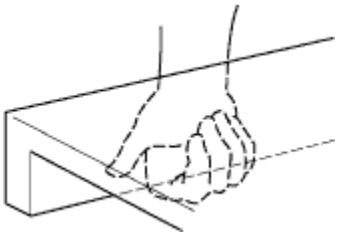
- Use the "power grip" on loads with handles.

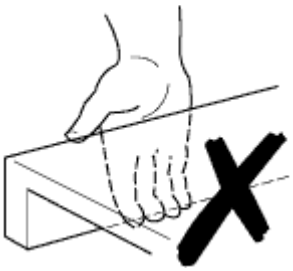


- Use the "hook grip" on loads with cut-out handholds.

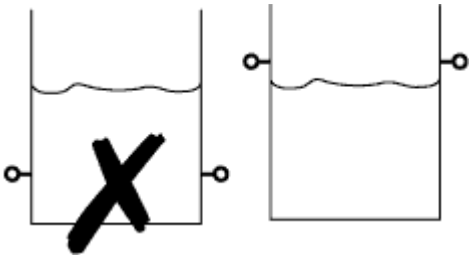


- Curl your fingers around the edge.
- Do not hold the load with finger tips.

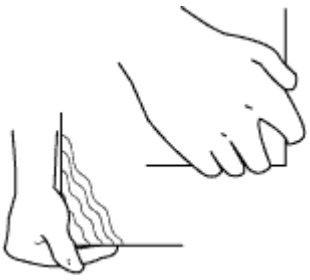




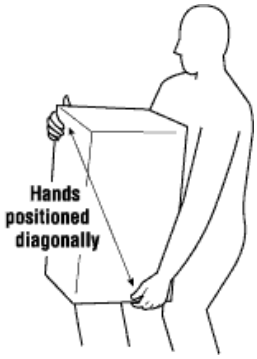
- Use containers with handles located more than halfway up the side of the container.



- Use the "ledge grip" to handle regularly shaped objects without handles.



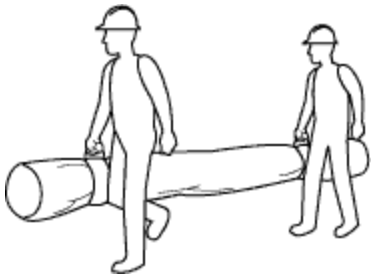
- Hold the object with hands placed diagonally.



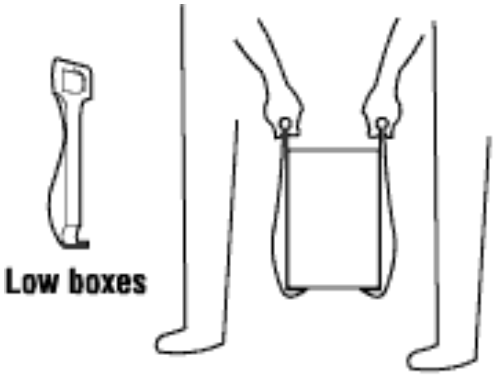
What else should I know about grip aids?

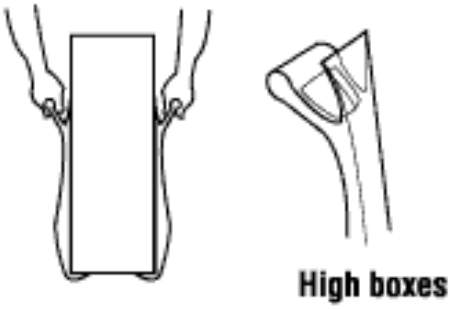
Use gripping aids to lift or carry awkward loads that do not have handles.

- Use lifting straps for cylindrical objects.

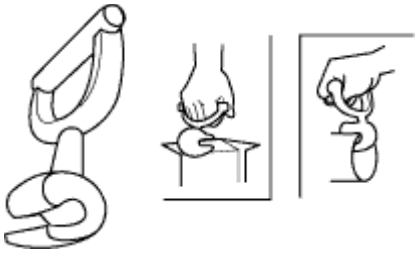


- Use carrying handles for boxes.

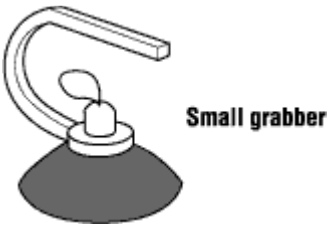


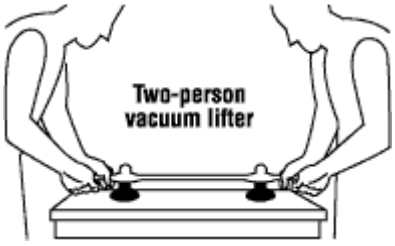


- Use a 'Gator grip' to handle awkward objects with sharp edges.



- Use vacuum lifters to handle sheet materials or plates.

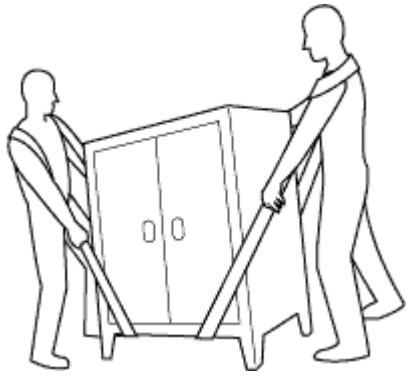




- Use furniture straps to lift and move heavy, bulky objects.

- Position buckle between the body and the load.

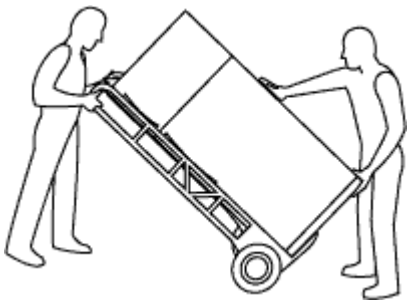
- Keep body straight.



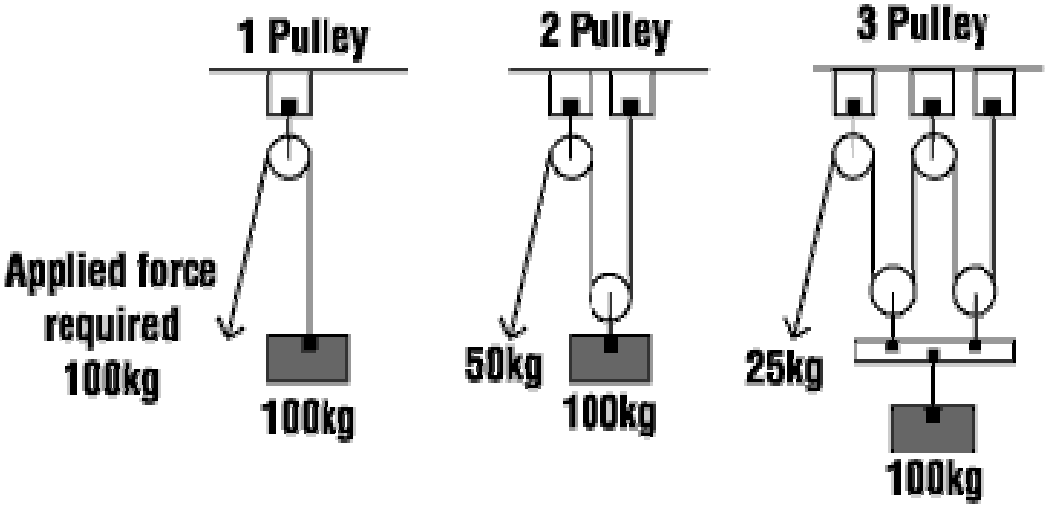
1.8.4 - HOISTING AND MOVING HEAVY OBJECTS

Selecting the right equipment for the task minimizes handling.

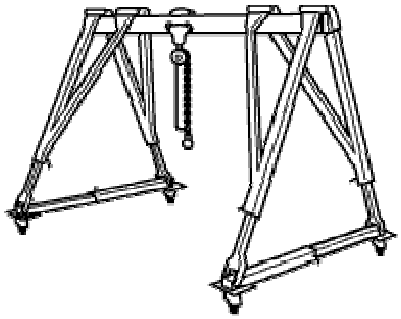
- Use a pulley to eliminate manual lifting.



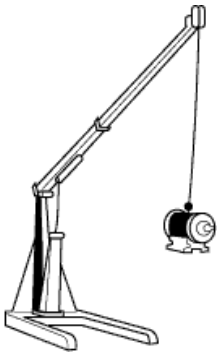
- Select multiple pulleys according to the weight of the object to be hoisted.



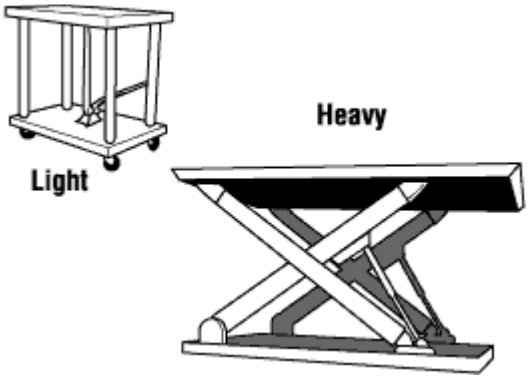
- Mount pulley on movable frame to lift and move heavy objects.



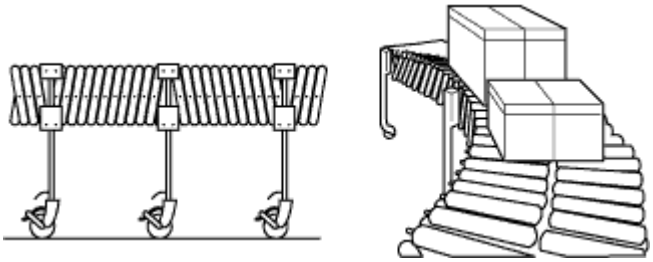
- Use a portable floor crane to lift and move heavy objects.



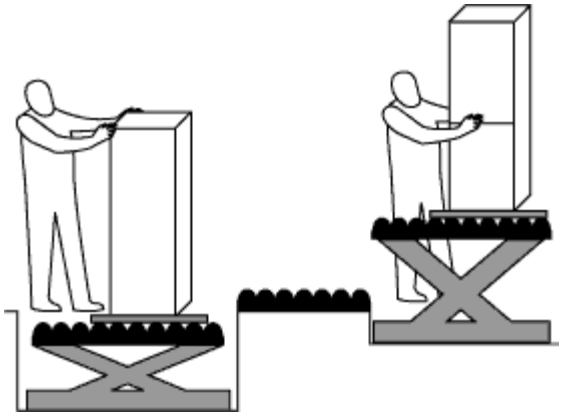
- Use lift tables to lift objects or to level work.
- Select the lift table according to the weight of the anticipated load.



- Use a portable conveyor to move materials.



- Use a combination of lift tables and rollers to move materials horizontally and vertically.



1.8.5 - CRANE AND HOIST HAND SIGNALS

When should the crane operator follow hand signals?

A crane operator should always move loads according to the established code of signals, and use a signaler. Hand signals are preferred and commonly used.

Who can give the hand signals? or Who can be a signaler?

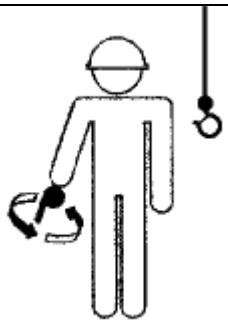
- a person qualified to give crane signals to the operator,
- there should be only one designated signaler at a time,
- if signalers are changing between each other, the one in charge should wear a clearly visible badge of authority,
- a crane operator should move loads only on signals from one signaler,
- a crane operator must obey STOP signals no matter who gives it.

What should you do when in charge of signaling?

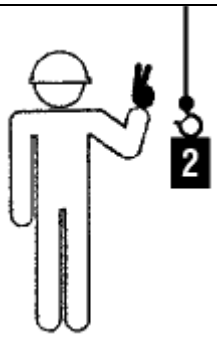
The signaler must:

- be in clear view of the crane operator,
- have a clear view of the load and the equipment,
- keep persons outside the crane's operating area,
- Never direct a load over a person.
- What are examples of some common hand signals?
- Hoist: With forearm vertical, forefinger pointing up, move the hand in a small horizontal circle.
- Lower: With an arm extended downward, forefinger pointing down, move the hand in small horizontal circles.
- Multiple Trolleys: Hold up one finger for block marked "1" and two fingers for a block marked "2." Regular signals follow.

Hoist

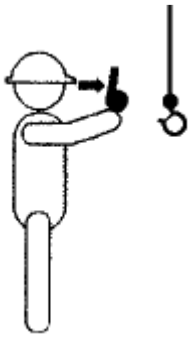


Lower

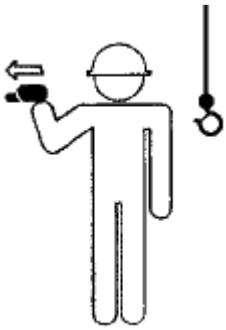


Multiple Trolleys

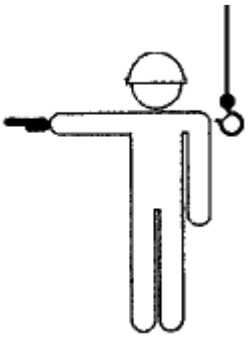
- Bridge Travel: Arm extended forward, hand open and slightly raised, make a pushing motion in direction of travel.
- Trolley Travel: Palm up, fingers closed, thumb pointing in direction of motion, jerk the hand horizontally.
- Stop: Arm extended, palm down, hold the position rigidly.



Bridge Travel

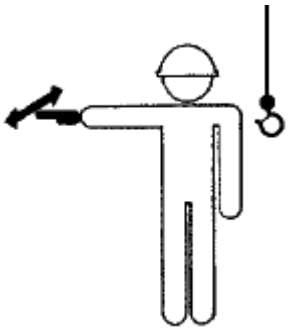


Trolley Travel

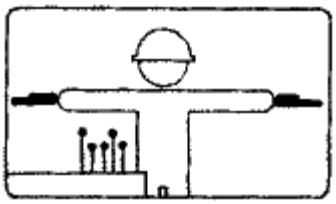


Stop

- Emergency Stop: Arm extended, palm down, move the hand rapidly right and left.
- Magnet Is Disconnected! : Crane operator spreads both hands apart, palms up.
- Dog Everything: Clasp hands in front of the body. Means PAUSE. This signal can be used on potentially risky occasions such as when it has started raining, when the load doesn't fit the space for which it was planned, or when a bystander gets too close to the action.



Emergency Stop



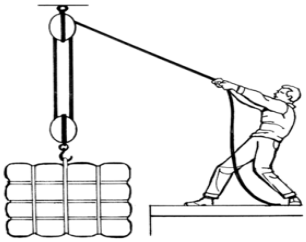
Magnet is Disconnected!

Dog Everything

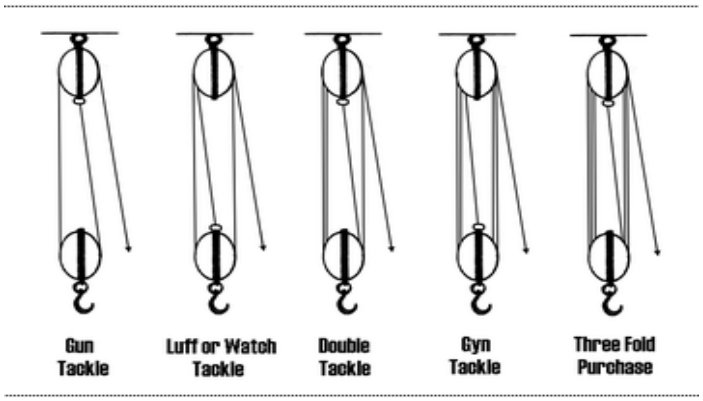
1.9 - LIFTING AIDS

1.9.1 - BLOCK & TACKLE.

A block and tackle is a system of two or more pulleys with a rope or cable threaded between them, usually used to lift or pull heavy loads. The block and tackle pulley was probably invented by Archimedes.



In the diagram on the right the mechanical advantage of the tackles shown is as follows:



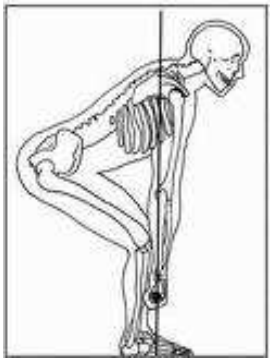
1.9.2 - MECHANICAL ADVANTAGE

If frictional losses are neglected, the mechanical advantage of a block and tackle is equal to the number of parts in the line that either attach to or run through the moving block, or the number of supporting ropes. For example, take a block and tackle with 2 sheaves on both the moving block and the fixed block. If the blocks are compared, one will have 4 lines running through its sheaves, and the other will have 4 lines running through its sheaves (including the part of the line being pulled or hauled), with a fifth line attached to a secure point on the block. If the hauling part is coming out of the fixed block, the block and tackle will have a mechanical advantage of 4. If the tackle is reversed, so that the hauling part is coming from the moving block, the mechanical advantage is now 5.

The mechanical advantage of a tackle dictates how much easier it is to haul or lift the load. A tackle with a mechanical advantage of 4 (a double tackle) will be able to lift 100 lbs with only 25 lbs of tension on the hauling part of the line.

1.9.3 - PULL LIFT

If you are beginning to teach simple machines to your students, by using the crane to introduce the concept of lifting heavy objects. Students easy to comprehend definitions of the simple machine and pulley. “A simple machine is anything that helps people do work.” “A pulley uses a wheel and a rope, or cable. The rope wraps over the wheel. When the rope is pulled at one end, the wheel helps lift the rope on the other end.” students are then shown examples of pulleys that they are probably familiar with, such as window blind cords and flag poles. The author continues to introduce and explain to the reader different types of pulleys in easy to understand text. For example, “Some pulleys use more than one wheel. More wheels make a load easier to lift. A block and tackle is a combination of several wheels and ropes that work together.” The author closes with another image of the crane and the idea that “Pulleys help keep the world moving.”

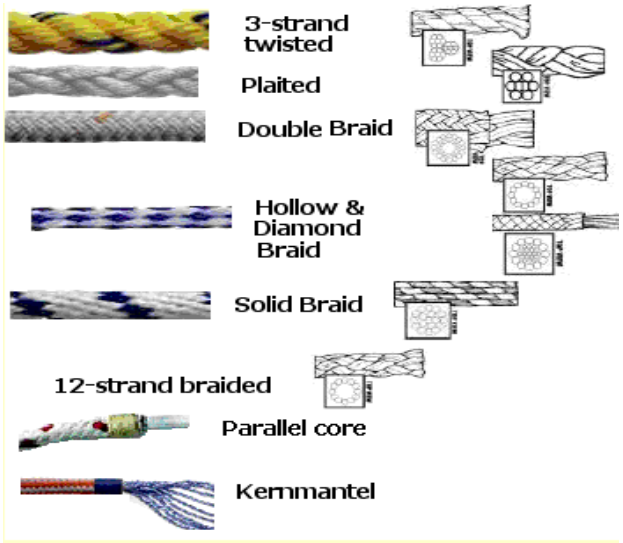


1.9.4 – ROPE

A rope is a length of fibers, twisted or braided together to improve strength for pulling and connecting. It has tensile strength but is too flexible to provide compressive strength (i.e. it can be used for pulling, but not pushing). Rope is thicker and stronger than similarly constructed cord, line, string, and twine.

Construction

Common materials for rope include natural fibers such as manila hemp, hemp, linen, cotton, coir, jute, and sisal. Synthetic fibers in use for rope-making include polypropylene, nylon, polyesters (e.g. PET, LCP, HPE, Vectran), polyethylene (e.g. Spectra), Aramids (e.g. Twaron, Technora and Kevlar) and polyaramids (e.g. Dralon, Tiptolon). Some ropes are constructed of mixtures of several fibers or use co-polymer fibers. Rope can also be made out of metal. Ropes have been constructed of other fibrous materials such as silk, wool, and hair, but such ropes are not generally available. Rayon is a regenerated fiber used to make decorative rope.



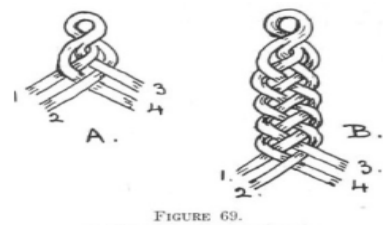
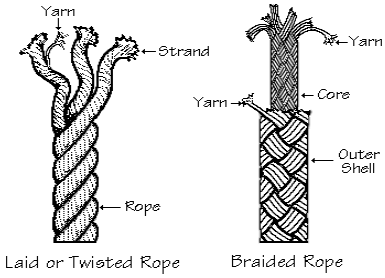


FIGURE 69.
Plaiting of pig rope band.



Types

1. Rock climbing ropes
2. Aerial rope
3. Laid or twisted rope
4. Braided rope → Single braid, Double braid (also called braid on braid), Solid braid
5. Kernmantle
6. Plaited rope
7. Endless winding rope

Usage

Rope is of paramount importance in fields as diverse as construction, seafaring, exploration, sports and communications and has been since prehistoric times. In order to fasten rope, a large number of knots have been invented for countless uses. Pulleys are used to redirect the pulling force to another direction, and may be used to create mechanical advantage, allowing multiple strands of rope to share a load and multiply the force applied to the end. Winches and capstans are machines designed to pull ropes.

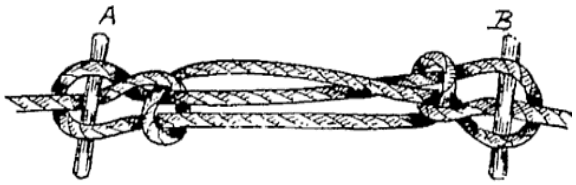


FIG. 83.—Sheepshank with toggle.

Handling rope

Rope made from hemp, cotton or nylon is generally stored in a cool dry place for proper storage. To prevent kinking it is usually coiled. To prevent fraying or unraveling, the ends of a rope are bound with twine (whipping), tape, or heat shrink tubing. The ends of plastic fiber ropes are often melted and fused solid. If a load-bearing rope gets a sharp or sudden jolt or the rope shows signs of deteriorating, it is recommended that the rope be replaced immediately and should be discarded or only used for non-load-bearing tasks. The average rope life-span is five years. Serious inspection should be given to line after that point. When preparing for a climb, it is important to stack the rope on the ground or a tarp and check for any "dead-spots". Avoid stepping on rope, as this might force tiny pieces of rock through the sheath, which can eventually deteriorate the core of the rope. Ropes may be flemished into coils on deck for safety and presentation/tidiness as shown in the picture.

Wire & Chain Slings

Wire Rope Sling

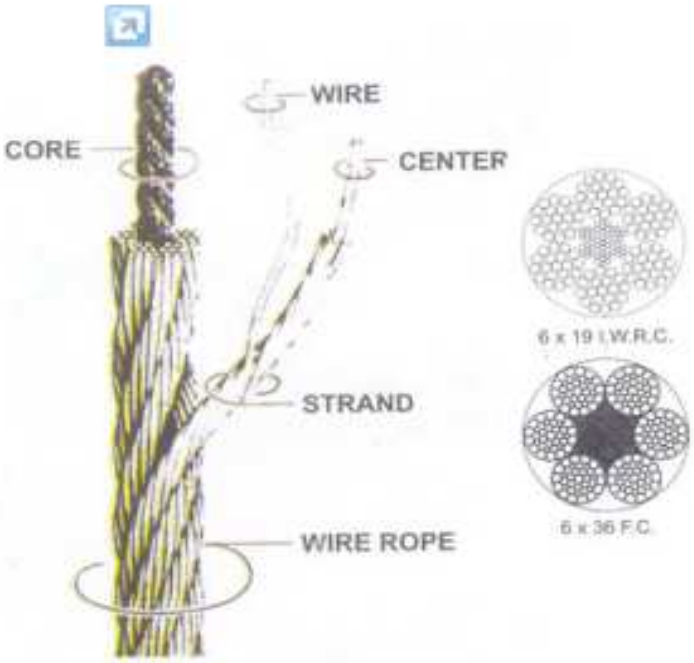
Wire rope sling consist of a number of a wire strands formed helically about a central axis in some cases, a single is rope.

1) Mass of rope in kg/100 mtrs. Shown above is approximate.

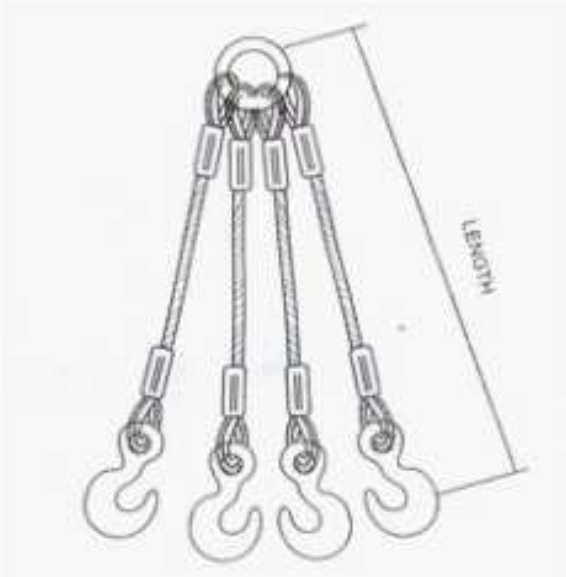
2) Sizes 15, 17, 21, 23, 25, 27, 29, 30, 31, 33, 35, 38 & 42 mm are not covered in IS specification.

3) The Breaking load figures shown above are in kilo Newtons. To obtain values in Metric Tonne

Maximum Safe Working Load = Breaking Load of Rope/6 = For Industrial



Four Leg Wire Rope Sling: four leg wire rope slings with varies features.
Ratting
Single Branch Sling
• Single branch slings shall have a working load limit equal to that of the Chain used in their construction.
Multi-Branch Slings
• Multi branch slings shall be rated at a uniform working load limit for any angle between branches of 900 – 1200 (450-600 to the vertical) or additionally at a uniform working load limit for any angle between branches of
900 – 1200 (450-600 to the vertical)



1.9.5 - UNIFORM LOAD METHOD

(a) Double branch slings: For all angles between branches from 0°- 900 (00. 45' to the vertical) L = 1.4 x WLL of a single branch made from similar chain When additionally marked for angles between branches of 900 – 1200 (450-600 to the vertical) WLL = 1 x WLL of a single branch made from similar chain.

(b) Three and four branch slings: For all angles between branches from00-900 (00-450 to the vertical)

WLL =2.1 xWLL of a single branch made from similar chain.

When additionally marked for angles between branches of 900 – 1200 (450-600 to the vertical)

WLL = 1.5 x WLL of a single branch made from similar chain.

PROOF LOAD TESTING

After final heat treatment slings with accessories shall be tested as an assembly multi chain slings shall be tested in sections. Individual sections of the chain slings shall be subjected to 20 times the load to which the section will be subjected when the assembly is subjected to as working load limit in accordance with the plan.

1.9.6 - LIFTING CLAMPS

Plate lifting clamps should be inspected before use to ensure that:

• all markings are legible;

• plate lifting clamps are free from nicks, gouges and cracks;

• a clamp with the correct Working Load Limit has been selected with respect to the load to be lifted;

• always make sure that the clamp is supporting the load correctly;

• the WLL should be applied in a straight pull and overloads are not permitted;

• clamps may not be heat treated as this may affect their Working Load Limit;

• never repair or reshape a clamp by welding, heating or bending as this may affect the Working Load Limit. It is required that the products are regularly inspected and that the inspection should take place in accordance with the safety standards given in the country of use. This is required because the products in use may be affected by wear, misuse, overloading etc. with a consequence of deformation and alteration of the material structure.

Inspection should take place at least every six months and even more frequently when the clamps are used in severe operating conditions.

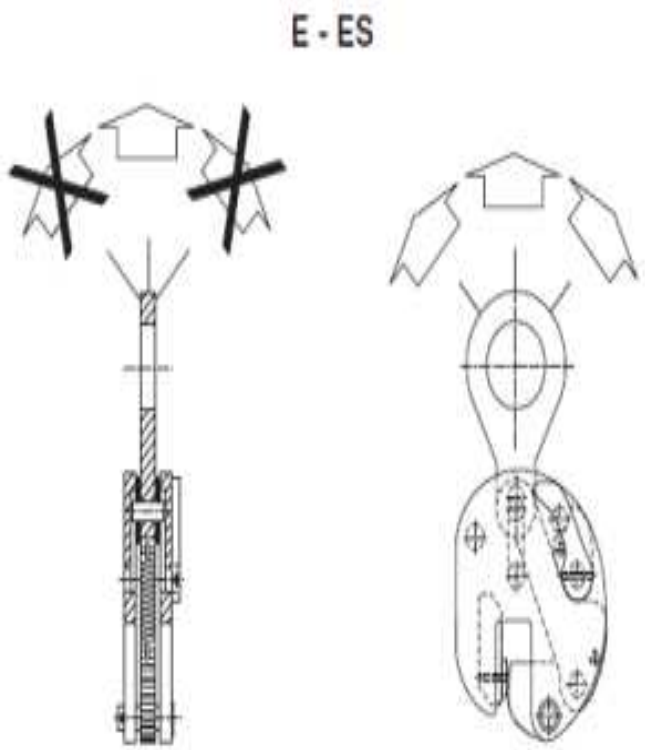


Plate lifting clamps type E and ES.
Do not side load the lifting eye.

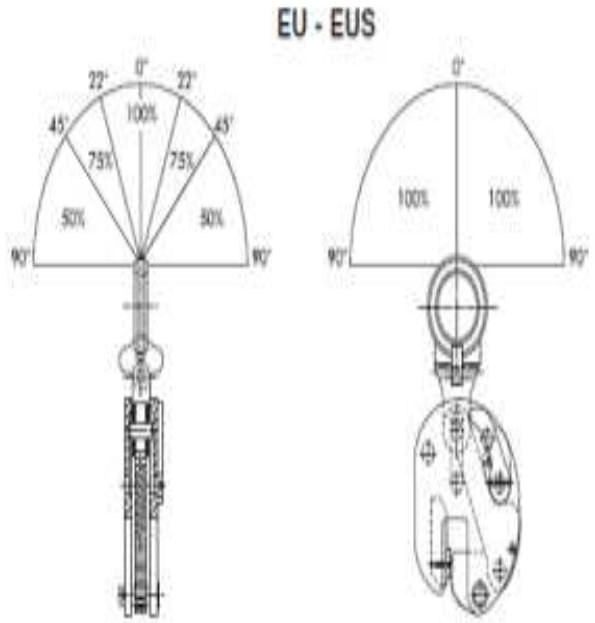


Plate lifting clamps type EU and EUS.
Load reduction should be applied as per load direction angle and corresponding remaining percentage of the Working Load Limit.

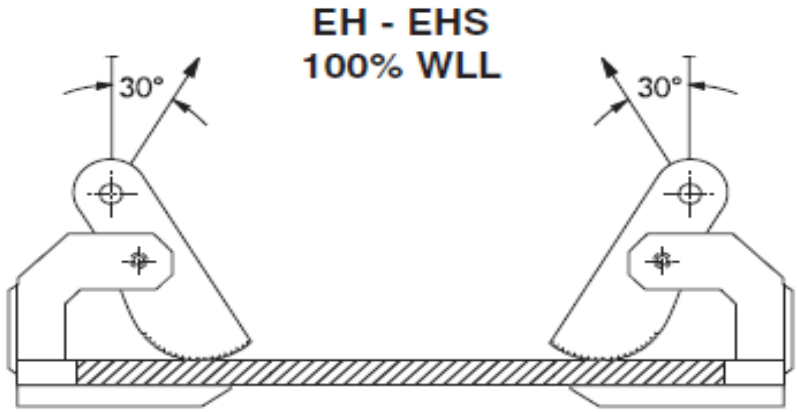
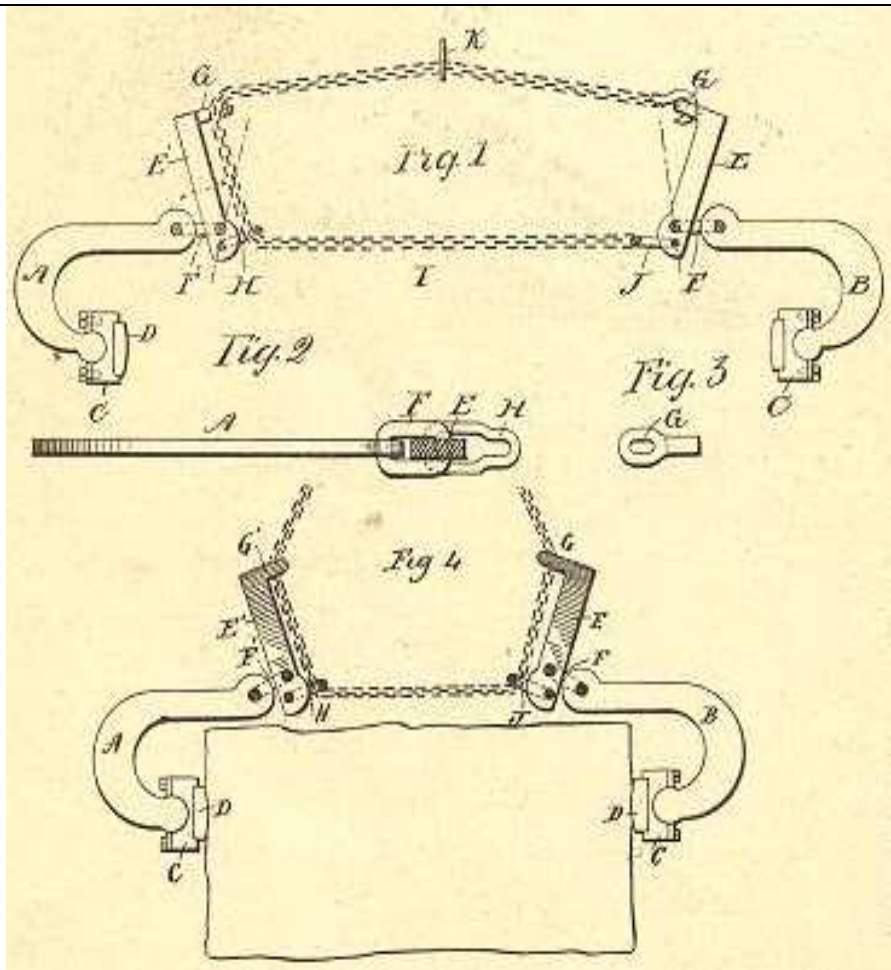


Plate lifting clamps type EH and EHS.
Full load may be applied up to a load direction angle of maximum 30˚. Do not use larger angles.

1.9.7 - LIFTING DOG

The device consists of two jaws A B, the end of which are provided with bearing-blocks C, which are preferably (sic) united to the ends of the jaws by a universal joint, and the bearing surfaces of the blocks are adapted to receive removable faces D of wood or other suitable material. The upper ends of the jaws are connected to Arms E and E' by Links F and F'. These arms are constructed at their upper ends with inwardly-projecting eyes G and G'. At the lower end of the arm E' and below the link F' a link H is attached, the outer end of the link being contracted, as shown in Figure 2. The lifting chain I is secured to a link J, which is attached to the lower end of the arm E below the link F. The said chain then passes upward through the link H and through the eye G' and through a link K, which is attached to a pulley-block of the crane, which is not shown, the said link K being contracted at its lower end in a similar manner to the link H, before described. The chain thence passes to and is hooked into the eye G. In adjusting the dogs upon a stone, the chain is drawn through the link H under a great tension as possible by hand, which tension throws the upper ends of the arms outward, as shown in full lines in Figure I. The chain then engages in the contracted portion of the link H. The chain is also engaged with the link K in the desired position for raising the stone at a proper angle. As the power is applied to raise the link K, the chain is drawn upward, and the first tendency will be to draw the upper ends of the arms forward, as shown in broken lines in Figure I. As the chain is securely attached to the lower ends of the arms by the links J H and below the point of connection between the jaws and the said arms, it necessarily follows that such strain will tend to clamp the blocks C C more securely against the stone before the actual raising takes place. By contracting the ends of the links H K their engagement with the chain at any desired point is made secure. It is apparent that various changes may be made in the manner of connecting the chain to the arms. For instance the free end of the chain might be passed downward through the eye G and engaged with the other end of the chain, or a continuous chain may be employed, as shown in Figure 4, which may be engaged by the links and through the link K of the lifting mechanism, such as arrangement being too apparent to require illustration.



1.9.8 - EYE- BOLT

An eye bolt is a screw with a loop on one end and threads on the other end. Eye bolts are commonly used to attach cables to objects, for instance attaching a string to the back of a painting to allow the painting to hang from a nail on a wall.

Machine screw threading

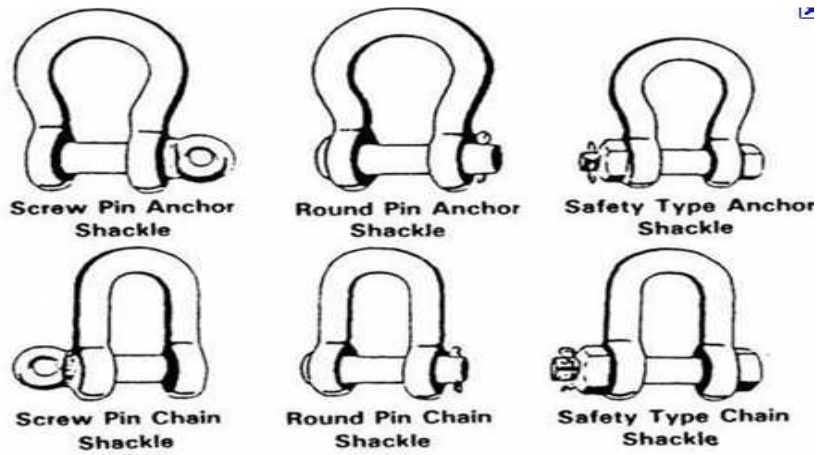
Machinery eye bolts are fully threaded and usually have a collar, which makes them suitable for use with angular loads up to 45°. Eye bolts without a shoulder should not be used for angular loads.

Wood screw threading

Wire eye lags (also referred to as screw thread eye bolts, eye screws, or turned/bent eye lags) have a wood screw thread for use in wood or lag anchors. Like wire eye bolts, wire eye lags are intended for light duty applications and should not be used for angular loads.

1.9.9 - SHACKLE

- A metal fastening, usually one of a pair, for encircling and confining the ankle or wrist of a prisoner or captive; a fetter or manacle
- A hobble for an animal.
- Any of several devices, such as a clevis, used to fasten or couple
- A restraint or check to action or progress. Often used in the plura
- To confine with shackles; fetter
- To fasten or connect with a shackle.
- To restrict, confine, or hamper

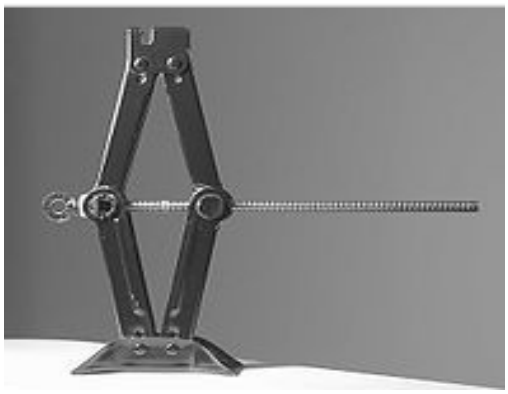


1.9.10 - JACK

A jack is a mechanical device used to lift heavy loads or apply great forces. Jacks employ a screw thread or hydraulic cylinder to apply very high linear forces

Types.

-Mechanical -House -Hydraulic -Strands



1.9.11 - TRESTLES

- Trestles consist of, from north to south, Upper Trestles (Uppers), Lower Trestles (Lowers), and Middle Trestles (Middles). North of Upper Trestles is the surf spot called Cottons. South of Middles is the surf spot called The Church.
- A horizontal beam or bar held up by two pairs of divergent legs and used as a support.
- A framework consisting of vertical, slanted supports and horizontal crosspieces supporting a bridge
- A framework in the form of a horizontal member supported at each end by a pair of splayed legs, used to carry scaffold boards, a table top, etc.
- A braced structural tower-like framework of timber, metal, or reinforced concrete that is used to support a bridge or ropeway
- A bridge constructed of such frameworks


1.9.12 - STANDS

- To rise to an upright position on the feet and assume or maintain an upright position as specified. (stand straight; stand to one side.)
- To maintain an upright or vertical position on a base or support (The urn stands on a pedestal) placed or situated (Building stands at the corner)
- Swing arm Stands are ideal to handle large samples. The high modularity allows to customize these stands depending on sample size and weight of the configuration. Focus arms and drives provide multiple mounting options and more safety features

1.9.13 - MONITOR STANDS

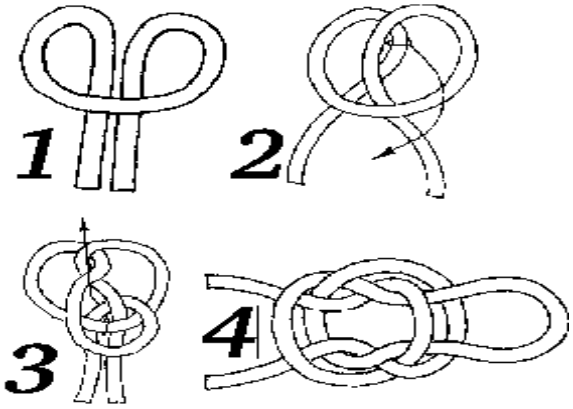
These monitor stands are ideal for any studio and are constructed of 3/4" furniture grade hardboard, finished in a black oak laminate. The speaker platform and base are 12" square. The bottom is easily removed to allow the 5" center post to be filled with bagged sand for acoustical de-coupling. Sold in pairs, these stands are shipped knocked down in one box and assemble in minutes

1.10 - HAZARDS OF MISHANDLING THE LIFTING EQUIPMENTS

1.10.1 - KNOTS IN SLINGS

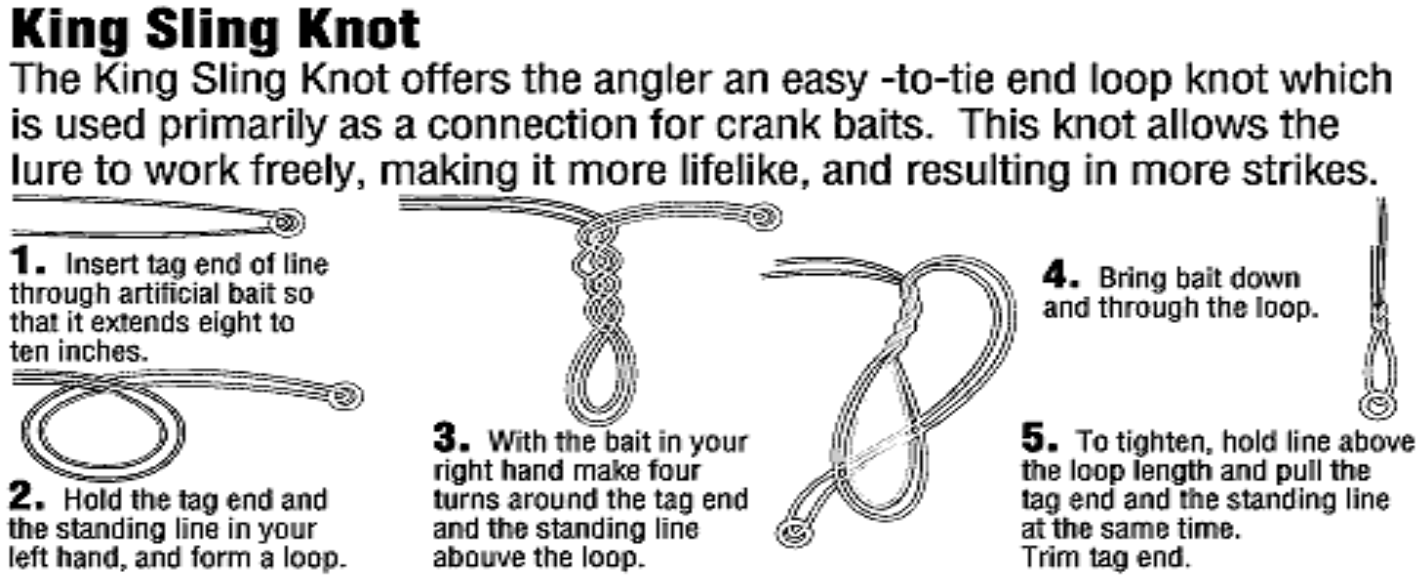
JUG SLING- There are binding knots, pioneering knots, angling knots, naudical knots, surgical knots. Climbers, the construction trade, electrical trade, plumbing trade; they all have special knots.

Always tie safety or backup knots with the tails of your water knot to help keep it from "creeping" untied. If there isn't enough webbing left over after tying the water knot to make the safety knots, the water knot itself is not safe and should be retied.



1.10.2 - DAMAGE SLINGS

Remember, damaged slings cannot lift as much as new or well-cared for older slings. Safe and proper use and storage of slings will increase their service life.



Fatigue - A wire rope must have the ability to withstand repeated bending without the failure of the wires from fatigue. Fatigue failure of the wires in a wire rope is the result of the development of small cracks under repeated applications of bending loads. It occurs when ropes make small radius bends. The best means of preventing fatigue failure of wire rope slings is to use blocking or padding to increase the radius of the bend.

Wire Rope Fatigue Failure

Wire Rope "Bird Cage"

Abuse - All other factors being equal, misuse or abuse of wire rope will cause a wire rope sling to become unsafe long before any other factor. Abusing a wire rope sling can cause serious structural damage to the wire rope, such as kinking or bird caging which reduces the strength of the wire rope. (In bird caging, the wire rope strands are forcibly untwisted and become spread outward.) Therefore, in order to prolong the life of the sling and protect the lives of employees, the manufacturer's suggestion for safe and proper use of wire rope slings must be strictly adhered to.

1.10.3 - LOAD WITH SHARP CORNER

That can be handle carefully because the danger of lifting Aid (Slings) damage.

Wire rope slings require special attention due to being subjected to severe wear, abrasion, impact loading, crushing, kinking, and overloading. Failure to provide blocking or protective pads permits sharp corners to cut into the sling. Pulling slings from under loads results in abrasion and kinking. Dropping loads on slings or running equipment over slings will cause crushing. Sudden starts and stops when lifting loads will increase stress on the sling. The recommended factor of safety for wire rope slings is 5:1 due to the severe service expended on slings, errors made in determining load weights, and the effects of sling stress from sling angles (fig. 3-20).

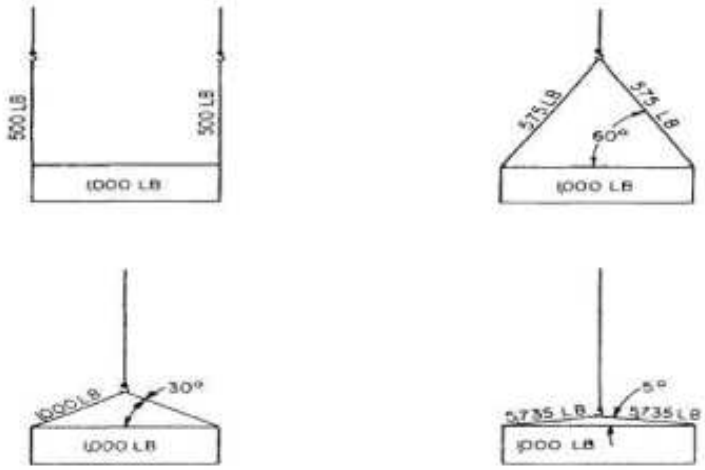


Figure 3-20.-Sling stress.

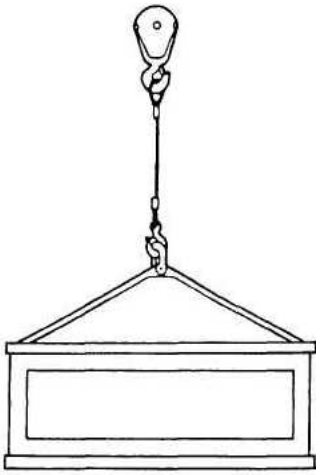
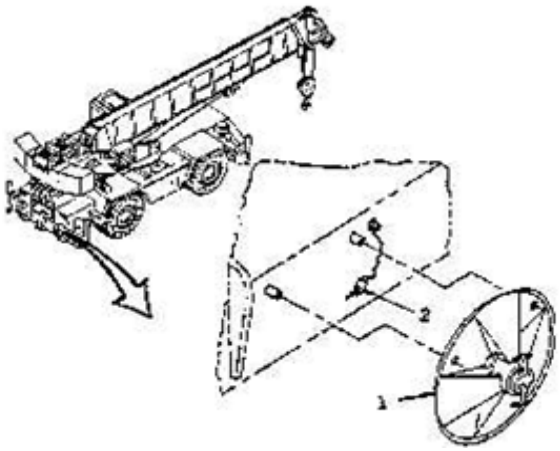


Figure 3-21.-Single-vertical hitch.

Single-Vertical Hitch : The single-vertical hitch (fig. 3-21) is a sling that supports a load by a single vertical part or leg of the

1.10.4 - LOOSE AND SWINGING LOAD

The load in pressure equipment which changes at frequent intervals. Load sway or swing on cranes is a pendulum effect where the load moves independently of the crane. This does not always matter while the load is in the air (although a big swing may affect the load radius and hence the stability of certain cranes). However, it becomes crucially important when the crane operator is trying to land the load accurately. Besides, however successful the operator is in overcoming the swing of the load, this will always take time and add to theoretical cycle times.



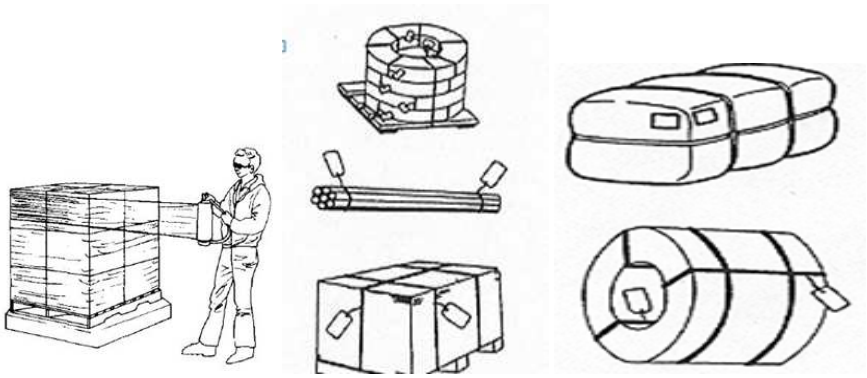
Big rig **looses its load.**

1.10.5 - WRAPPED LOAD

Studies into the most effective means of providing unit load stabilization. They have identified load shifting, ripped or loose packaging, crushing and water damage as the major causes of these types of problems.

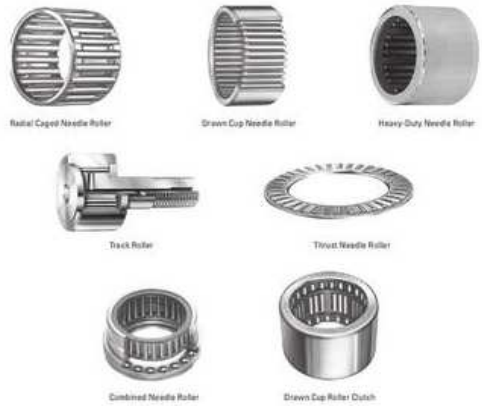
Load bearing and dynamic forces caused by movement, impacts, and vibrations such as that from a loaded tractor-trailer traveling along a highway can lead to large stresses, causing displacements of product and packaging within the load. Throw in environmental factors, such as potholes, poor suspension system, rough road surfaces, flexing of the trailer floor, and-or improperly balanced tires spells a formula towards disaster.

The key component to unit load stability is the use of various load stabilization materials and practices. Common techniques typically include banding or strapping along with the use of stretch wrapping. It is known that steel strapping provides the best tensile strength binding over polyester strapping as well as over that of Mini (generally about 5" wide) Stretch Wrap binding techniques.



1.10.6 - GREASED LOADS

Engineering a bearing types and cages - continued needle roller bearing ... bearing cross section thickness and raceway construction needle roller ... capability comparison based on suitable oil lubrication bearing design bearing ... load limiting speed slope tolerance grease life friction precision cross section.



1.10.7 - DEFINITION OF FRICTION COEFFICIENT

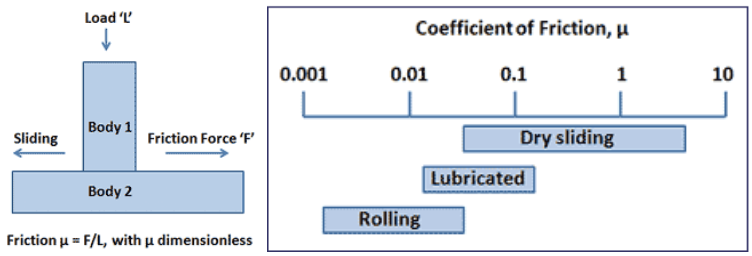
If the normal applied load between one body and another is L, and the resultant friction force required to slide the bodies is F, then the friction coefficient 'μ' is given by μ=F/L.

1.10.8 - RANGE OF FRICTION COEFFICIENTS

Dry sliding friction coefficients vary from 0.05 for PTFE under high loads to as high as 5.0 for metals like gold sliding in vacuum. Typical values for engineering steels are between 0.3 and 0.6.

Lubricated sliding friction coefficients vary from about 0.03 under hydrodynamic conditions (complete separation of the sliding surfaces by the lubricant film) to around 0.15 under boundary conditions (when there is surface contact through the lubricant film).

Rolling friction coefficients (with hard steel balls and raceways) vary from about 0.002 when fully lubricated to about 0.05 when running dry.



Material Handling under Adverse Condition.

Monday 10.09.01 @ 14h30. The sea grows increasingly powerful, with many of the larger swells crashing over the deck. Two anchor chains at the front of the Ikan Tanda are under enormous pressure. Weather forecast is that these conditions will persist for the rest of the week.

Monday 10.09.01 @ 14h30. Another massive salvo, sweeping right across the deck and bridge of the ship. There is apparently a slight crack to the ship's hull, and under these adverse conditions, one must question how long she can remain intact. Most of the fuel and all the cargo remain on board.

1.11 – MEASURES TO ENSURE SAFETY WHILE USING LADDERS

1.11.1 - INTRODUCTION

Before starting to use a ladder, care must be taken to ensure that it is securely set in place. A third of all reported fall-from-height incidents involve ladders and stepladders – on average this accounts for 14 deaths and 1200 major injuries to workers each year. Many of these injuries are caused by inappropriate or incorrect use of the equipment. This guidance is to help employers or employee:

- Know when to use a ladder
- Decide how to go about selecting the right sort of ladder for the particular job
- Understand how to use it
- Know how to look after it
- Take sensible safety precautions

1.11.2 - HAZARDS

Injury statistics show that the use of ladders presents many hazards. Injuries involving ladders frequently cause permanent disability.

The hazards associated with ladders include:

- Falls from ladders
- Struck by falling ladders
- Struck by materials falling from ladders
- Tripping over ladders (erect or lying on floor)
- Lifting heavy ladders
- Striking persons or objects when carrying ladders
- Contact with electrical equipment

1.11.3 - CONTROLS

Develop a policy on ladders which covers use, inspection, repair, and disposal. Emphasize compliance with the legal requirements covering ladders. Establish safe practices for the use of ladders. Make sure they are followed.

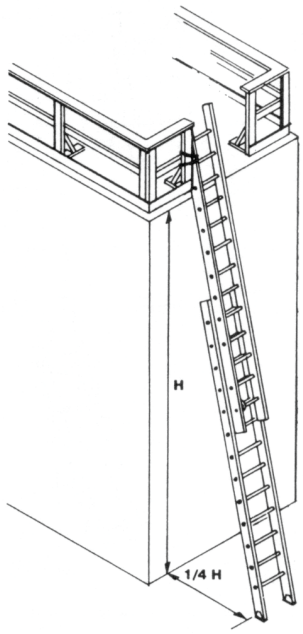


Figure 1: A properly raised ladder

Straight Ladders

- Use the right ladder for the job.
- Inspect the ladder before and after use.
- Tag and remove defective ladders for repair.
- Get help when moving heavy or long ladders.

- Make sure that your shoes are safe. If they are wet or muddy, you could slip.
- Put the ladder up correctly. Follow the “4 to 1” rule: One foot back for each four feet up. When you set up the ladder, count the number of rungs up to the point where the ladder touches the wall. The bottom of the ladder must be one rung’s length out from the wall for every four rungs up the wall.
- Secure the top of the ladder, as needed.
- In aisles or where there may be the danger of traffic, have someone hold the ladder. Post a warning sign, if necessary.
- Secure the top and bottom of a ladder when using it to access a platform or scaffold.
- Face the ladder when ascending or descending.
- Maintain 3 point contact.
- Hoist materials or attach them to a belt. Do not carry materials in your hands.
- Make sure that only one person at a time is on the ladder.
- Don’t stretch or reach beyond the side rails of a ladder. You could lose your balance.
- Never stand any higher than on the third rung from the top of a ladder.
- Keep metal and wet wooden ladders away from live electrical circuits.
- Avoid the dangerous practices shown below.

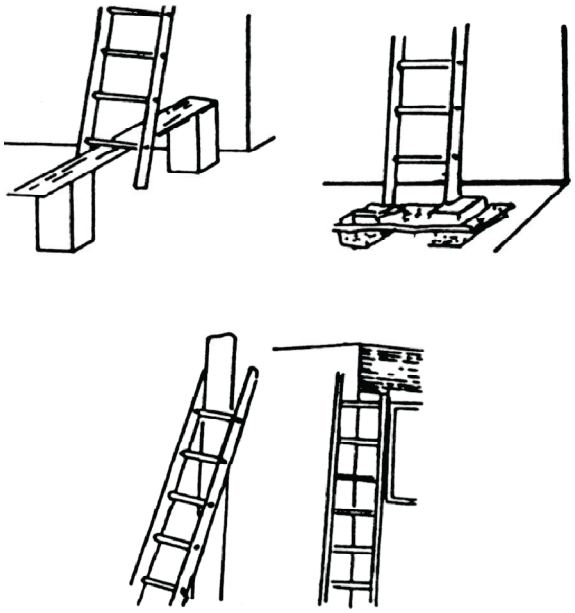


Figure 2: Dangerous Practices

Stepladders

- Many of the rules for straight ladders apply to stepladders a well.
- Never use a step ladder as a straight ladder.
- Use a platform type stepladder with side rails.
- It provides safer support and a more stable working surface.
- Lock the stepladder – spread the legs to their limit and ensure the braces are locked.

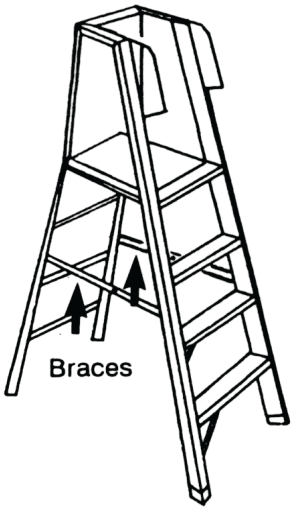


Figure 3: A Platform Type Step Ladder

1.11.4 - MAINTENANCE

Establish a program for regular maintenance of ladders, which includes:

- Inspecting for common defects such as broken rungs, split side rails, worn or broken safety feet, and oil or grease which can make climbing surfaces slippery
- Destroying ladders that cannot be safely repaired
- Prohibiting repairs which include tying or binding with wire
- Prohibiting the painting of ladders, as this can hide cracks or other weak points

1.12 - RISKS ASSOCIATED WITH ELECTRICAL UTENSILS

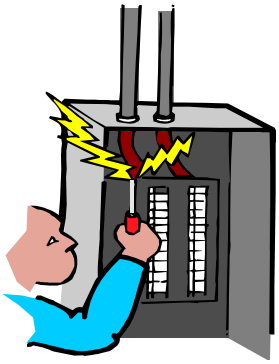
1.12.1 - ELECTRICAL INJURIES

There are three direct and two indirect types of electrical injuries:

- Direct:
  - Electrocution or death due to electrical shock
  - Electrical shock
  - Burns
- Indirect:
  - Falls
  - Fire

When an electrical shock enters the body it may produce different types of injuries. Electrical shock results in internal and external injury to body parts or the entire body often resulting in death. After receiving a "jolt" of electricity all or part of the body may be temporarily paralyzed and this may cause loss of grip or stability. A person may also involuntarily move as a result of receiving an electrical shock, resulting in a fall. Internal or external burns may result from contact with electricity.

1.12.2 - ELECTRICAL SHOCK



- An electrical shock is received when electrical Current passes through the body.
- You will get an electrical shock if a part of your body completes an electrical circuit by:
  - Touching a live wire and an electrical ground, or
  - Touching a live wire and another wire at a different voltage.

Electricity travels in closed circuits, and its normal route is through a conductor. Electric shock occurs when the body becomes a part of the circuit.

Grounding is a physical connection to the earth, which is at zero volts.

The metal parts of electric tools and machines may become energized if there is a break in the insulation of the tool or machine wiring. A worker using these tools and machines is made less vulnerable to electric shock when there is a low-resistance path from the metallic case of the tool or machine to the ground. This is done through the use of an

equipment grounding conductor—a low-resistance wire that causes the unwanted current to pass directly to the ground, thereby greatly reducing the amount of current passing through the body of the person in contact with the tool or machine.

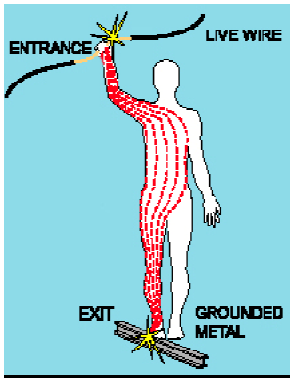
Shock Severity

- Severity of the shock depends on:
  - Path of current through the body.
  - Amount of current flowing through the body (amps).
  - Duration of the shocking current through the body.

Other factors that may affect the severity of the shock are:

- The voltage of the current.
- The presence of moisture
- The general health of the person prior to the shock.

Low voltages can be extremely dangerous because, all other factors being equal, the degree of injury increases the longer the body is in contact with the circuit.

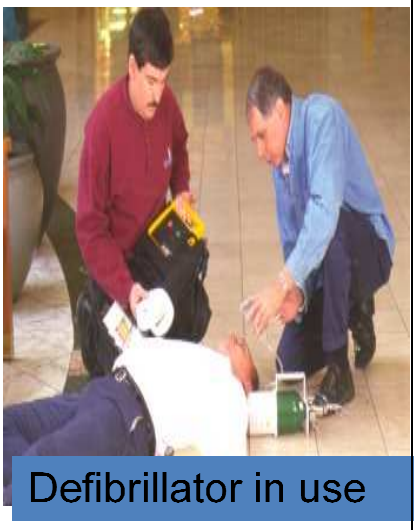


The resistance of the body varies based on:

- The amount of moisture on the skin (less moisture = more resistance)
- The size of the area of contact (smaller area = more resistance)
- The pressure applied to the contact point (less pressure = more resistance)
- Muscular structure (less muscle = less resistance)

Dangers of Electrical Shock

- Currents above 10 mA can paralyze or "freeze" muscles.
- Currents more than 75 mA can cause a rapid, ineffective heartbeat -- death will occur in a few minutes unless a defibrillator is used.
- 75 mA is not much current – a small power drill uses 30 times as much.


Defibrillator in use

For example, 1/10 of an ampere (amp) of electricity going through the body for just 2 seconds is enough to cause death.

Currents above 10 mA can paralyze or "freeze" muscles. When this "freezing" happens, a person is no longer able to release a tool, wire, or other object. In fact, the electrified object may be held even more tightly, resulting in longer exposure to the shocking current. For this reason, hand-held tools that give a shock can be very dangerous. If you can't let go of the tool, current continues through your body for a longer time, which can lead to respiratory paralysis (the muscles that control breathing cannot move). You stop breathing for a period of time. People have stopped breathing when shocked with currents from voltages as low as 49 volts. Usually, it takes about 30 mA of current to cause respiratory paralysis.

1.12.3 - BURNS

- Most common shock-related injury.
- Occurs when you touch electrical wiring or equipment that is improperly used or maintained.
- Typically occurs on hands.
- Very serious injury that needs immediate attention.

Shock-related injuries include burns, internal injuries, and injuries due to
Involuntary muscle contractions.
The most common shock-related injury is a burn. Burns suffered in electrical incidents may be one or more of the following three types.

Electrical burns cause tissue damage, and are the result of heat generated by the flow of electrical current through the body. These are one of the most serious injuries you can receive and require immediate attention.

Arc or Flash burns are caused by high temperatures near the body produced by an electrical arc or explosion. Attend to them immediately.

Thermal contact burns occur when skin comes in contact with overheated electric equipment, or when clothing is ignited by an electrical incident.

1.12.4 - FALLS

- Electric shock can also cause indirect injuries.
- Workers in elevated locations who experience a shock may fall, resulting in serious injury or death.

It's Your Job to Know!

- ✓ **Know the hazards of electricity**
- ✓ **Know the equipment**
- ✓ **Use Safe Work Practices**
- ✓ **Inspect your PPE before each use**
- ✓ **Don't work on energized circuits**

  without permission

1.12.5 - ELECTRICAL HAZARDS

- Electrical accidents are caused by a combination of three factors:
- Unsafe equipment and/or installation.
- Workplaces made unsafe by the environment.

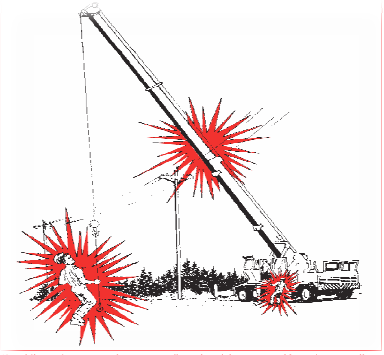
  Unsafe work practices.

Electrical shocks, fires, or falls result from these hazards:

- Exposed electrical parts
- Overhead power lines
- Inadequate wiring
- Defective insulation
- Improper grounding
- Overloaded circuits
- Wet conditions
- Damaged tools and equipment
- Improper PPE

1.12.6 - ELECTRICAL HAZARDS FOR CRANE AND HEAVY EQUIPMENT OPERATORS

- The crane is the most common type of equipment which most often contacts overhead power lines.
- When contact happens, the rigger or ground worker is most often electrocuted (90% of time)



If mobile equipment touches a power line, electricity can travel from the power line

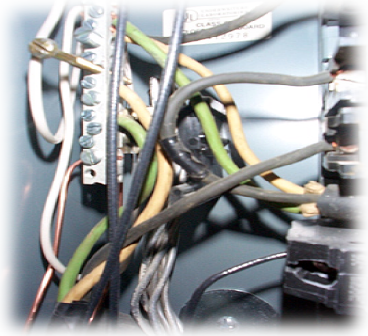
1.12.7 - SAFE PRACTICES OPERATING CRANES AND MOBILE EQUIPMENT

- Make it a HABIT to look up **before** you unload or load a crane from a truck or lowboy. Make sure there are no overhead lines before you start.
- Operate equipment at a slower-than-normal rate in the vicinity of power lines.
- Exercise caution near long spans of overhead power lines, since wind can cause the power lines to sway laterally and reduce the clearance between the crane and the power line.
- Mark safe routes where equipment must repeatedly travel beneath power lines.
- Exercise caution when traveling over uneven ground that could cause the crane to weave or bob into power lines.
- Keep all personnel on ground well away from the crane whenever it is close to power lines.
- Prohibit persons from touching the crane or its load until a signal person indicates that it is safe to do so.

Hazard – Exposed Electrical Parts

- Cover removed from wiring or breaker box.

Control – Isolate Electrical Parts



- Use guards or barriers.
- Replace covers.

Hazard - Overhead Power Lines

- Usually not insulated.
- Examples of equipment that can contact power lines:
    - Crane
    - Ladder
    - Scaffold
    - Backhoe
    - Scissors lift
    - Raised dump truck bed
    - Aluminum paint roller

Control - Overhead Power Lines

- Stay at least 10 feet away.
- Post warning signs.
- Assume that lines are energized.
- Use wood or fiberglass ladders, not metal.
- Power line workers need special training & PPE.

Hazard - Inadequate Wiring

- Hazard - Wire too small for the current.
- Example - Portable tool with an extension cord that has a wire too small for the tool.
    - The tool will draw more current than the cord can handle, causing overheating and a possible fire without tripping the circuit breaker.
    - The circuit breaker could be the right size for the circuit but not for the smaller-wire extension cord.

Control – Use the Correct Wire

- Wire used depends on operation, building materials, electrical load, and environmental factors.
- Use fixed cords rather than flexible cords.
- Use the correct extension cord.

Hazard – Defective Cords & Wires

- Plastic or rubber

  covering is missing.
- Damaged extension cords

  & tools.

Extension cords may have damaged insulation. Sometimes the insulation inside an electrical tool or appliance is damaged. When insulation is damaged, exposed metal parts may become energized if a live wire inside touches them. Electric hand tools that are old, damaged, or misused may have damaged insulation inside. If you touch damaged power tools or other equipment, you will receive a shock. You are more likely to receive a shock if the tool is not grounded or double-insulated.

Hazard – Damaged Cords

- Cords can be damaged by:
  - Aging
  - Door or window edges
  - Staples or fastenings
  - Abrasion from adjacent materials
  - Activity in the area
- Improper use can cause
  - shocks, burns or fire.

The normal wear and tear on extension and flexible cords at your site can loosen or expose wires, creating hazardous conditions. Cords that are not 3-wire type, not designed for hard-usage, or that have been modified, increase your risk of contacting electrical current.

Control – Cords & Wires

- Check before use.
- Use only cords that are 3-wire type.
- Use only cords marked for hard or extra-hard usage.
- Use only connection devices, and fittings equipped with strain relief.
- Remove cords by pulling on the plugs, not the cords.
- Cords not marked for hard or extra-hard use must be taken out of service immediately.

Insulation is the most common manner of guarding electrical energy.

Extension cords must be 3-wire type so they may be grounded, and to permit grounding of any tools or equipment connected to them.

Extension cords when exposed to "normal" construction use can experience rapid deterioration. When this happens, conductors with energized bare wires can be exposed. Conductors can break or come loose from their terminal screws, specifically the equipment grounding conductor. If that occurs, the equipment grounding for the tool in use is lost.

1.12.8 - GROUNDING

- Grounding creates a low resistance path from a tool to the earth to disperse unwanted current.
- When a short circuit occurs, energy flows to the ground, protecting you from electrical shock, injury and death

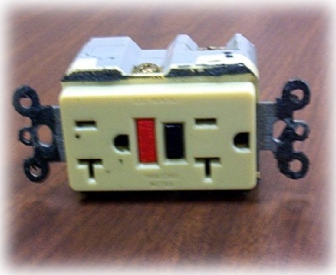
1.12.9 - HAZARD – IMPROPER GROUNDING

- Tools plugged into improperly grounded circuits may become energized.
- Broken wire or plug on extension cord.
- Some of the most frequently violated OSHA standards.

The most frequently violated OSHA electrical regulation is improper grounding of equipment and circuitry. The metal parts of an electrical wiring system that we touch (switch plates, ceiling light fixtures, conduit, etc.) should be grounded and at 0 volts. If the system is not grounded properly, these parts may become energized. Metal parts of motors, appliances, or electronics that are plugged into improperly grounded circuits may be energized. When a circuit is not grounded properly, a hazard exists because unwanted voltage cannot be safely eliminated. If there is no safe path to ground for fault currents, exposed metal parts in damaged appliances can become energized.
Extension cords may not provide a continuous path to ground because of a broken ground wire or plug.

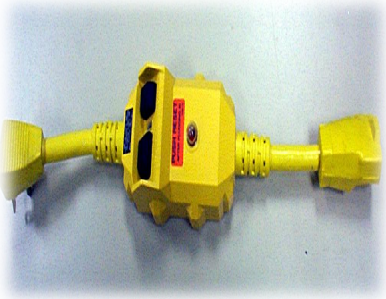
Electrical systems are often grounded to metal water pipes that serve as a continuous path to ground. If plumbing is used as a path to ground for fault current, all pipes must be made of conductive material (a type of metal). Many electrocutions and fires occur because (during renovation or repair) parts of metal plumbing are replaced with plastic pipe, which does not conduct electricity.

Control – Use GFCI (ground-fault circuit interrupter)



- Protects you from shock.
- Detects difference in current between the black and white wires.
- If ground fault detected, GFCI shuts off electricity in 1/40th of a second.
- Use GFCI's on all 120-volt, single-phase, 15- and 20-ampere receptacles, or have an assured equipment grounding conductor program.

1.12.10 - HAZARD – OVERLOADED CIRCUITS



Hazards may result from:

- Too many devices plugged into a circuit, causing heated wires and possibly a fire.
- Damaged tools overheating.
- Lack of over current protection.

If the circuit breakers or fuses are too big (high current rating) for the wires they are supposed to protect, an overload in the circuit will not be detected and the current will not be shut off. A circuit with improper over current protection devices – or one with no over current protection devices at all – is a hazard.

Control - Electrical Protective Devices

- Automatically opens circuit if excess current from overload or ground-fault is detected – shutting off electricity.
- Includes GFCI's, fuses, and circuit breakers.

To prevent too much current in a circuit, a circuit breaker or fuse is placed in the circuit. If there is too much current in the circuit, the breaker "trips" and opens like a switch. If an overloaded circuit is equipped with a fuse, an internal part of the fuse melts, opening the circuit. Both breakers and fuses do the same thing: open the circuit to shut off the electrical current

The basic idea of an over current device is to make a weak link in the circuit. In the case of a fuse, the fuse is destroyed before another part of the system is destroyed. In the case of a circuit breaker, a set of contacts opens the circuit. Unlike a fuse, a circuit breaker can be re-used by re-closing the contacts. Fuses and circuit breakers are designed to protect equipment and facilities, and in so doing, they also provide considerable protection against shock in most situations. However, the only electrical protective device whose sole purpose is to protect people is the ground-fault circuit-interrupter.

Temporary Lights

Protect from contact and damage, and don't suspend by cords unless designed to do so.

Clues that Electrical Hazards Exist

- Tripped circuit breakers or blown fuses.
- Warm tools, wires, cords, connections, or junction boxes.
- GFCI that shuts off a circuit.
- Worn or frayed insulation around wire or connection.

There are "clues" that electrical hazards exist. For example, if a GFCI keeps tripping while you are using a power tool, there is a problem. Don't keep resetting the GFCI and continue to work. You must evaluate the "clue" and decide what action should be taken to control the hazard.

There are a number of other conditions that indicate a hazard.

- Tripped circuit breakers and blown fuses show that too much current is flowing in a circuit. This could be due to several factors, such as malfunctioning equipment or a short between conductors. You need to determine the cause in order to control the hazard.
- An electrical tool, appliance, wire, or connection that feels warm may indicate too much current in the circuit or equipment. You need to evaluate the situation and determine your risk.
- An extension cord that feels warm may indicate too much current for the wire size of the cord. You must decide when action needs to be taken.

- A cable, fuse box, or junction box that feels warm may indicate too much current in the circuits.
- A burning odor may indicate overheated insulation.
- Worn, frayed, or damaged insulation around any wire or other conductor is an electrical hazard because the conductors could be exposed. Contact with an exposed wire could cause a shock. Damaged insulation could cause a short, leading to arcing or a fire. Inspect all insulation for scrapes and breaks. You need to evaluate the seriousness of any damage you find and decide how to deal with the hazard.
- A GFCI that trips indicates there is current leakage from the circuit first; you must decide the probable cause of the leakage by recognizing any contributing hazards. Then, you must decide what action needs to be taken.

Preventing Electrical Hazards – Planning

- Plan your work with others.
- Plan to avoid falls.
- Plan to lock-out and tag-out equipment.
- Remove jewelry.
- Avoid wet conditions and overhead power lines.

Avoid Wet Conditions

- If you touch a live wire or other electrical component while standing in even a small puddle of water you'll get a shock.
- Damaged insulation, equipment, or tools can expose you to live electrical parts.
- Improperly grounded metal switch plates & ceiling lights are especially hazardous in wet conditions.
- Wet clothing, high humidity, and

perspiration increase your chances of being electrocuted.

Summary

- Electrical equipment must be:
  - Listed and labeled.
  - Free from hazards.
  - Used in the proper manner.
- If you use electrical tools you must be:
  - Protected from electrical shock.
  - Provided necessary safety equipment.

	Safety	**Module No.**	1.13
		Prepared by	Imran Ali
Course	Certificate in Engineering Skills	**Duration**	30 - Mins
Teaching Aid			
Topic	**Awareness regarding electrical circuit**		

1.13 - AWARENESS REGARDING ELECTRICAL CIRCUIT

1.13.1 - OVERVIEW

An electric shock occurs when a person comes into contact with an electrical energy source. Electrical energy flows through a portion of the body causing a shock. Exposure to electrical energy may result in no injury at all or may result in devastating damage or death. Burns are the most common injury from electric shock. Our body conducts electricity, so any physical contact with an electrical current has the potential of causing us some sort of an electric shock injury, or even death via electrocution.

1.13.2 - CAUSES

Adults are prone to high voltage shock caused by mischievous exploration and exposure at work. Many variables determine what injuries may occur, if any. These variables include the type of current (AC or DC), the amount of current and pathway the electricity takes through the body. Low voltage electricity (less than 500 volts) does not normally cause significant injury to humans. Exposure to high voltage electricity (greater than 500 volts) has the potential to result in serious damage.

- When two wires have different potential differences (voltages), current will flow if they are connected together

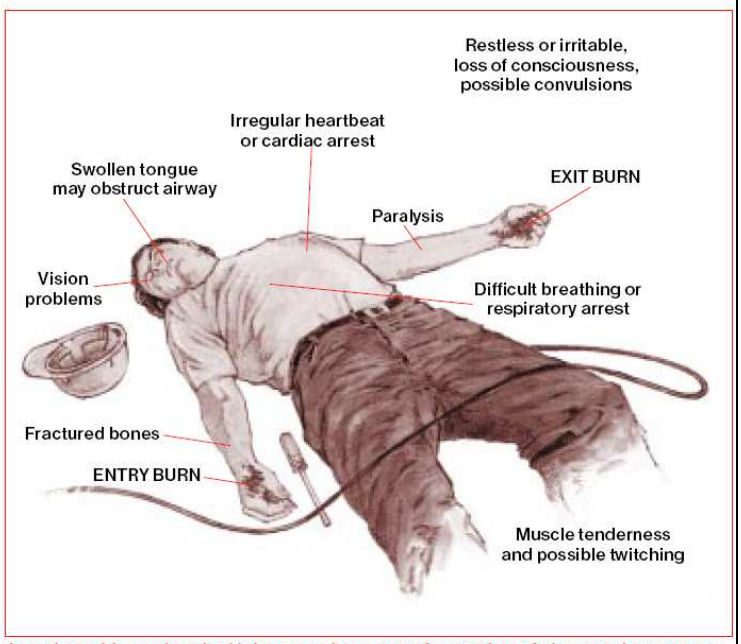
- If we come into contact with an energized (live) black wire, and are also in contact with the white grounded wire, current will pass through our body and WE WILL RECEIVE A SHOCK.

- If we are in contact with an energized wire or any energized electrical component, and also with any grounded object, WE WILL RECEIVE A SHOCK.

- We can even receive a shock when we are not in contact with a ground. If we contact both wires of a 220-volt cable, WE WILL RECEIVE A SHOCK and possibly be electrocuted.

1.13.3 - SYMPTOMS

- A person who has suffered an electric shock may have very little external evidence of injury or may have obvious severe burns. The person could even be in cardiac arrest.
- Burns are usually most severe at the points of contact with the electrical source and the ground. The hands, heels, and head are common points of contact.
- In addition to burns, other injuries are possible if the person has been thrown clear of the electrical source by forceful muscular contraction. Consideration should be given to the possibility of a spine injury. The person may have internal injuries especially if he or she is experiencing any shortness of breath, chest pain, or abdominal pain.
- Pain in a hand or foot or a deformity of a part of the body may indicate a possible broken bone resulting from the electric shock.



A worker with an electrical injury may have any of a number of signs and symptoms.

- In children, the typical electrical mouth burn from biting an electric cord appears as a burn on the lip. The area has a red or dark, charred appearance.

1.13.4 - TREATMENT

- Do not approach the person who has been electrocuted until you are sure the area is safe. First, break contact between the person and the current source. Best is to shut off the current at the main fuse box. Do not use the switch of the appliance. If this is not possible, use a wooden stick to separate the person from the appliance. Stand on a rubber mat, or stack of newspapers or another non-conducting material.
- Check the ABC's: airway, breathing, circulation and start CPR if necessary. Check for shock.
- Call an ambulance.
- With high voltages, the person may have been thrown into the air and may have sustained back, head or neck injuries. Handle with care.
- Cover any burnt area with a sterile gauze bandage or a clean cloth. Electrical burns are always worse than they seem. Get to a doctor

1.13.5 - MEDICAL TREATMENT

Treatment depends on the severity of the burns or the nature of other injuries found.

- Burns are treated according to severity.
- Minor burns may be treated with topical antibiotic ointment and dressings.
- More severe burns may require surgery to clean the wounds or even skin grafting.
- Severe burns on the arms, legs, or hands may require surgery to remove damaged muscle or even amputation.

Other injuries may require treatment.

- Eye injuries may require examination and treatment by an eye specialist.
- Broken bones require splinting, casting, or surgery to stabilize the bones.
- Internal injuries may require observation or surgery.

1.13.6 - PREVENTION

Steps to prevent electrical injury depend primarily on the age of people involved.

- Do not allow children to play with any electrical cord.
- Limit use of extension cords and be sure the cord is rated for the current (measured in amps) that will be drawn by the device being powered.
- Use outlet covers to protect infants from exploring electrical outlets.
- Update old, ungrounded electrical outlets to grounded (3-point) systems. Replace outlets near any water (sink, tub) with fused (GFCI) outlets.

In children older than 12 years, most electrical injuries result from exploring and activities around high-power systems. Explain to adolescent children that they should not climb on power towers, play near transformer systems, or explore electrified train rails or other electrical systems.

Among adults, use of common sense can help reduce electrical injury. People who work with electricity should always check that the power is off before working on electrical systems. Avoid use of any electrical device near water. Be careful of standing in water or when working with electricity.

Use caution when outdoors during a thunderstorm containing lightning. Protect yourself from lightning strikes by seeking shelter in a sturdy building or crouching low and away from trees and metal objects if caught outdoors.

1.14 - DANGERS FOR A PERSON WHEN IS CONTACT WITH ELECTRIC SUPPLY

1.14.1 - INTRODUCTION

Contact with live electrical conductors is a serious risk because a proportion of the current passing through the human body may also pass through the heart. The current through the heart can disrupt the heart's operation by forcing it into fibrillation, which then stops blood being pumped around the body.

Virtually every workplace uses electricity as an energy source. People who carry out work with, on or near electrical equipment need to be aware of the dangers. Harm can be caused to anyone when they are exposed to 'live parts' that are either touched directly or indirectly by means of some conducting object or material. Voltages over 50 volts AC or 120 volts DC are considered hazardous.

1.14.2 - WHY IS ELECTRICITY IMPORTANT?

Electricity can kill. Each year about 1,000 accidents at work involving electric shock or burns are reported to the Health and Safety Executive (HSE). Around 30 of these are fatal, most of them arising from contact with overhead or underground power cables. Shocks from faulty equipment can cause severe and permanent injury and can also lead to indirect injuries, due to falls from ladders, scaffolds or other work platforms. Faulty electrical appliances can also lead to fires that, as well as causing injuries, could cause damage to plant, equipment and property

1.14.3 - WHO IS AFFECTED MOST AT RISK FROM ELECTRICITY?

Anyone could be exposed to the dangers of electricity whilst at work. Those most at risk include maintenance staff, those working with, electrical plant, equipment and machinery, and people working in harsh environments such as construction sites. Most electrical accidents occur because individuals:

- Are working on or near equipment which is thought to be dead but which is in fact live
- Are working on or near equipment which is known to be live but where those involved are without adequate training or appropriate equipment, or they have not taken adequate precautions
- Misuse equipment or use electrical equipment which they know to be faulty

1.14.4 - GOOD PRACTICE WHEN DEALING WITH ELECTRICITY

Always consider the potential hazards regarding electricity in your risk assessments. For example:

- Contact with live parts causing shock and burns (normal mains voltage, 230 volts AC, can kill)
- Faults which could cause fires
- Fire or explosion where electricity could be the source of ignition in a potentially flammable or explosive atmosphere, e.g. in a spray paint booth
- Where and how electricity is used, (the risks are generally greatest in harsh conditions). Think about the implications when using electricity in wet surroundings, out of doors or in cramped or confined space.

Take sensible precautions, for example:

- **Reduce the voltage**
  - portable tools are available which can be run from a 110 volts, centre-tapped-to-earth supply, (usually from a transformer)
  - where electrically powered tools are used, battery operated are safest
  - temporary lighting can be run at lower voltages, e.g. 12, 25, 50 or 110 volts
- **Provide a safety device**
  - A Residual Current Device (RCD) is a device that detects some, but not all, faults in the electrical system and rapidly switches off the supply. The best place for an RCD is built into the main supply or the socket-outlet
- **Carry out preventative maintenance**
  - All electrical equipment and installations should be maintained to prevent danger. This should include an appropriate system of formal visual inspection and, where necessary, Portable Appliance testing (PAT)
- **Work safely**
  - Make sure that people working with electricity are competent to do the job

1.14.5 - EXAMPLES OF WORK INVOLVING COMMON HAZARDS

HAZARD WORK ACTIVITY

Voltage between phases

- Working on polyphase installation or systems.
- Wiring / testing / servicing of switchboards / motors/ heaters/ controllers.
- Working on exposed busbars/catenary wires etc.

Voltage between phases and earth

- Working on single phase & polyphase systems.
- Wiring/testing/servicing of switchboards / motors / heaters / controllers.

- Working on exposed busbars/catenary wires etc.
- General electrical work.

Voltage across undischarged capacitors

- Work with apparently isolated plant with reactive storage components.

Multiple supply sources

- Working in large installations or systems with standby power systems, multiple distribution boards, where source of power in a single location or zone is uncertain, such as solar energy sources.

Electrical testing in hazardous locations

- Electrical testing in confined area with explosive gas mixture, fumes, vapour or dust which is inadequately ventilated.

Damp working conditions

- Working in situations where condensation, spillage, drainage or seepage occurs and results in wet surroundings.

Common hazards of working on or near low voltage installations or systems

Below are examples of typical sources of hazard that, individually or in combination, could lead to electric shock or severe injury. The list is not in order of priority

(a) Voltages between phases.

(b) Voltages between phases and earth.

(c) Voltages between live exposed conductors and surrounding metal framework.

(d) Voltages across undischarged capacitors.

(e) Voltages on disconnected conductors - particularly neutrals.

(f) Multiple supply sources (more than one source of supply or live circuit may be available on the premises).

(g) Voltages between live exposed conductors and the surrounding environment (including metalwork, damp situations, other conductive surfaces and persons nearby).

(h) Electrical testing or operating equipment with open enclosures in hazardous areas (as defined by AS/NZS 3000:2000).

(i) Lower voltages - for example ELV (extra low voltage) may be hazardous in a cramped situation with dampness, heat or water on the floor, especially when the worker is lying on the floor.

(j) In installations or systems where the MEN (multiple earthed neutral) system is used, the rise in the earth potential in an installation due to a high impedance return path to the distribution neutral.

(k) Damp conditions.

(l) Switched off circuits becoming live.

(m) Induced voltages.

1.14.6 - COMMON NON-ELECTRICAL HAZARDS ENCOUNTERED IN ELECTRICAL WORK

Other hazards that may contribute to risks while carrying out electrical work include:

- Confined spaces (where there may be a hazardous atmosphere - see below);
- Lack of sufficient light to work safely;
- Lack of ventilation leading to uncomfortable, hot and humid working conditions;
- Excessive fatigue, due to pressure of deadlines or other factors;
- Obstacles to getting the equipment switched off;
- Using a gas flame near exposed electrical conductors (a flame is a conductor);
- Temperature rise as a result of combustion;
- Fall from heights;
- Cramped working conditions;
- Explosive atmospheres;
- Static from clothing made from wool, wool blends, nylons and polyvinyl (unless treated with an antistatic process);
- Electric tools and equipment (e.g. hand lamps, drills, saws, torches and test instruments);
- Personal effects (e.g. rings, jewellery, cigarette lighters, matches, hearing aids, mobile phones and pagers, transistor radios and similar);
- General work activities (e.g. welding, cutting, brazing, using hand saws, drilling of all types, hammering and chiseling);
- Static from the rubbing (friction effects) of plastics;
- Hot metal surfaces due to drilling, grinding welding, etc;
- Use of metallic tape measures;
- Excavation associated with electrical work; and
- Molten metal from arcs.

Examples of confined spaces are:

- Storage tanks, process vessels, boilers, pressure vessels, silos, and other tank like compartments;
- Open topped spaces such as pits and degreasers; and
- Pipes, sewers, shafts, ducts, and similar structures.

1.14.7 - IDENTIFYING INDIVIDUAL NEEDS

When considering the risk, any one of the following factors trigger special consideration of individual worker's needs:

- Is the person physically fit for a task involving exposure to low voltage electricity (e.g. are they able to climb to heights to work on an overhead conductor)?
- Does the worker have a visual deficiency (e.g. do they have a visual colour deficiency)?
- Do they suffer from any heart, circulatory or other diseases (e.g. do they have a pacemaker)?
- Are they taking any medication, which may increase their vulnerability to work in electrical environments (e.g. - Are the staff working excessively long hours?
- Are they experienced in, and have they been properly
- Do they suffer from claustrophobia?

1.14.8 - CONTROL MEASURES FOR ALL ELECTRICAL WORK

Electrical safety is primarily dependent upon appropriate job planning and correct testing procedures and techniques.

The first aim always should be to eliminate the hazard. Usually, the simplest way is to ensure the electricity supply is isolated. However, electrical equipment should not be assumed to be de energized after isolation. Testing must be done prior to touching. Workers must be appropriately trained and competent in test procedures and in the use of testing equipment.

Elimination

Eliminate the risk of shock or burns by:

(a) Switching off the supply;

(b) Isolating the supply;

(c) Taking precautions to ensure that the supply remains isolated by locking-off and/or tagging, or by disconnecting the load side of the isolator and tying back disconnected conductors;

(d) Proving the supply is de-energized by using an approved testing instrument.

Use of personal protective equipment (PPE)

Frequently personal protective equipment (PPE) is necessary, such as:

(a) A safety helmet with face shield (as appropriate);

(b) Safety glasses/face shields (anti-flash);

(c) Safety boots;

(d) Protective clothing;

(e) Approved insulating gloves;

(f) Approved insulated tools; and

(g) Approved insulating sheeting.

Workers must be trained to be competent in the use of PPE. All the above practices should be described in the employer's or your own (if self-employed) safe working procedures, and rigorously carried out.

Control measures to be taken before working live in emergencies

The OHS Regulation (clause 207) specifies the following precautions Working live procedures can be implemented in emergencies only:

(a) When the risks of de-energizing are greater;

(b) After a written risk assessment has been completed;

(d) After determining how it can be done safely; and

(e) When authorization has been obtained from the person in control of the premises.

ADVICE TO WORKERS
WORK SAFELY
ISOLATE THE SUPPLY
SECURE LOCKOUT DEVICE AND TAG
PROVE IT IS DE-ENERGISED
BEFORE WORKING LIVE -- STOP! !
IS IT AN EMERGENCY SITUATION?
HAVE YOU DONE A RISK ASSESSMENT?
HAVE YOU BEEN AUTHORISED BY YOUR EMPLOYER?
TEST BEFORE YOU TOUCH
NEVER ASSUME IT IS DEAD
OTHERWISE YOU MAY BE!

1.14.9 - ELECTRICAL TESTING

It is often necessary for testing to be carried out live, such as testing meters, voltage, load, and phasing. The OHS Regulation requires employers to ensure that persons conducting tests for electrical system integrity and operability conduct the tests in a safe manner using a safe system of work, appropriate PPE and appropriate test equipment.

TAGGING OFF PROCEDURES:

Preparation for work on de-energized equipment

Do not assume that electrical equipment is de-energized after isolation. Testing must be done prior to touching. Workers must be appropriately trained and competent in the test procedures and in the use of testing equipment.

Identification

It is necessary to clearly identify the electrical equipment to be worked on and the appropriate point of supply. Identification should include labeling that is both consistent and clear at the equipment to be worked on and at all points of possible isolation, for example at the control isolator and main point of supply.

Isolation

The electrical equipment to be worked on must be isolated from all sources of supply. Where isolation is effected at a removable or rack-out circuit-breaker or combined fuse switch, it must be racked out or removed to provide a visible break for isolation verification, then locked open and danger tagged. When returning after being absent from the immediate work area, it is imperative that checks and tests are carried out to ensure that the electrical equipment being worked on is still isolated when you return, to safeguard against inadvertent reconnection by another person.

Tagging

Where practicable, appropriate tags should be placed at all points of switching.

Where appropriate, the tags should be signed and dated by all personnel involved in the work, or by the supervisor in charge of the work party. Tags should only be removed with the permission of all the signatories to the tags or, if this is not possible, by the signatories' immediate supervisor. Identification labels should also include warnings for any abnormal hazards, for example, multiple points of supply.

Cutting Cables

When carrying out work that involves cutting existing cables, the cable must be treated as live and the procedures for working on live electrical equipment adhered to, until positive tests can be made at the point where the cable is to be cut that prove the cable is de-energized.

1.15 - IMPORTANCE OF PROPER GROUNDING

1.15.1 – REASON OF GROUNDING.

The main reason for grounding is safety.

- **Personnel:** for every person who may come in contact with high voltages in the event of a electrical fault
- **Equipment:** this will insure the equipment in your home or business is protected in the event of a fault.
- **Noise Control:** this will help eliminate transients from any source. These transients can cause numerous issues from insulation breakdown to sensitive equipment failure.

All ground rods at a facility should be connected where a building's ground connections come together. This includes all steel, metal water pipes, etc.

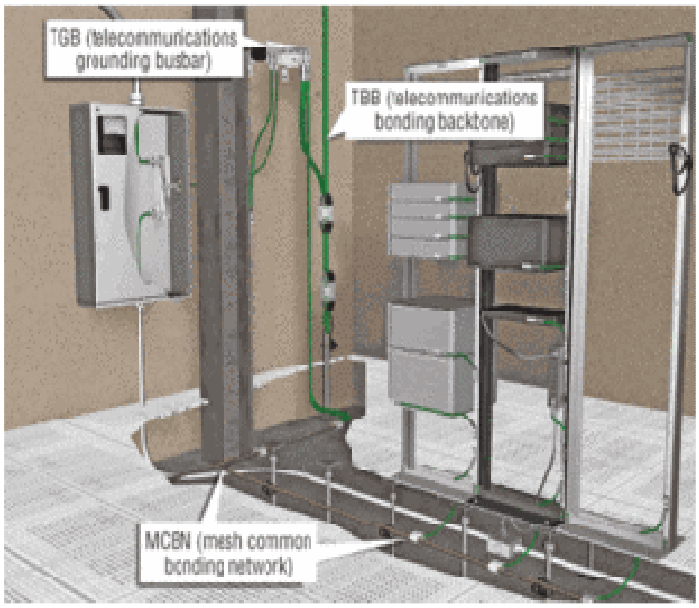
These ground rods can be combined at the service entrance to decrease ground resistance.

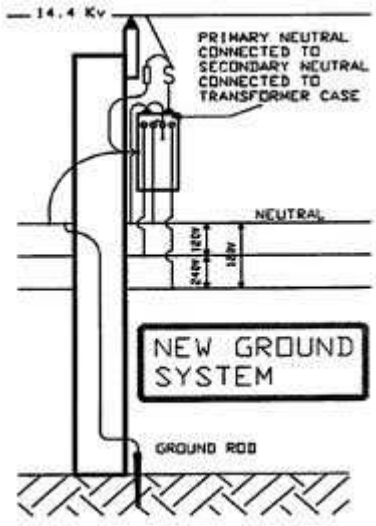
- In the event of a lightning strike near the facility, the ground voltage for all equipment will rise equally. If there were separate ground connections and this occurred you could have both personnel and equipment safety issues.

The service entrance is the only place where a ground should be connected to a neutral.

If multiple neutrals are tied to grounds throughout your system, this could cause parallel paths for neutral current which can cause protection circuit misoperation in the facility and equipment.

Typical bonding and grounding





1.15.2 - TYPICAL CONNECTION PROBLEMS

Problems	Possible Causes
Burning smell at a Circuit Breaker Panel, J-box or Outlet	Bad connection, faulty conductor inside panel, J-box or Outlet
Warm CB panel	Bad circuit breakers or connections
Buzzing sound	Arcing from bad connection
Burnt insulation	Wire or circuit overload, bad conductor or connector
No Voltage	Tripped breaker, blown fuse or broken conductor
Intermittent Voltage	Bad connection or arcing

A properly grounded receptacle has three prongs. Two are provided by the power company, and are called "load" and "neutral". (Load is sometimes called "hot".) The third is called "ground" in the USA, or "earth" in most other countries, and is simply a wire with a good connection to the ground under your feet, i.e., the dirt. A properly grounded receptacle has three prongs. Two are provided by the power company, and are called "load" and "neutral". (Load is sometimes called "hot".) The third is called "ground" in the USA, or "earth" in most other countries, and is simply a wire with a good connection to the ground under your feet, i.e., the dirt.

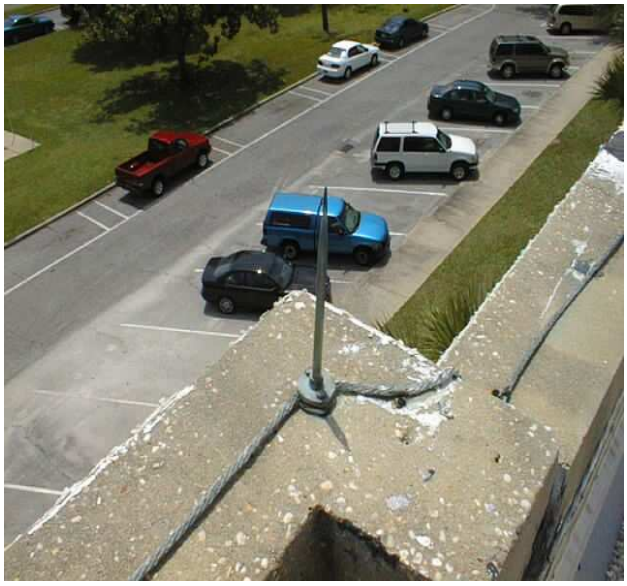
1.15.3 - WHAT IS GROUNDING?

A ground is ***not*** any of the following:

- A ground is ***not*** a wire screwed into the wall
- A ground is ***not*** a wire stuck into the dirt
- A ground is ***not*** a wire connected to just anything metal and big

A ground is a wire connected to an uninterrupted metal electrical conductor that deeply penetrates the ground, usually two meters deep in Bangkok. (Outside of Bangkok, this sometimes takes a sledgehammer.) In dry places, it takes multiple conductors and/or deeper conductors. In Bangkok, a two meter copper rod is usually quite sufficient, because the ground is very wet starting at less than a meter of depth. You can push a copper rod down two meters with your hands in Bangkok (sitting on it at the end, such as putting a board on top of the rod when it's low), since the ground is just mud and clay, no rocks, and with the water table barely under the surface.

You will find that **electrical grounding** is something that is becoming more and more popular in new homes. There are several reasons why this is something that is very important to do. Electrical grounding is not actually necessary to do but it is something that is very beneficial for your appliances.



1.15.4 - GROUNDING SYSTEMS.

There are basically six (6) grounding systems in use. The six (6) systems are the:

1. Equipment Grounds
2. Static Grounds
3. Systems Grounds
4. Maintenance Grounds
5. Electronic Grounds
6. Lightning Grounds

Equipment grounds: An equipment ground is the physical connection to earth of non-current carrying metal parts. This type grounding is done so that all metal part of equipment that personnel can come into contact with are always at or near zero (0) volts with respect to ground. All metal parts must be interconnected and grounded by a conductor in such away as to ensure a path of

lowest impedance for flow of ground fault current. Typical items (equipment) to be grounded are; electrical motor frames, outlet boxes, breaker panels, metal conduit, support structures, cable tray, to name a few.

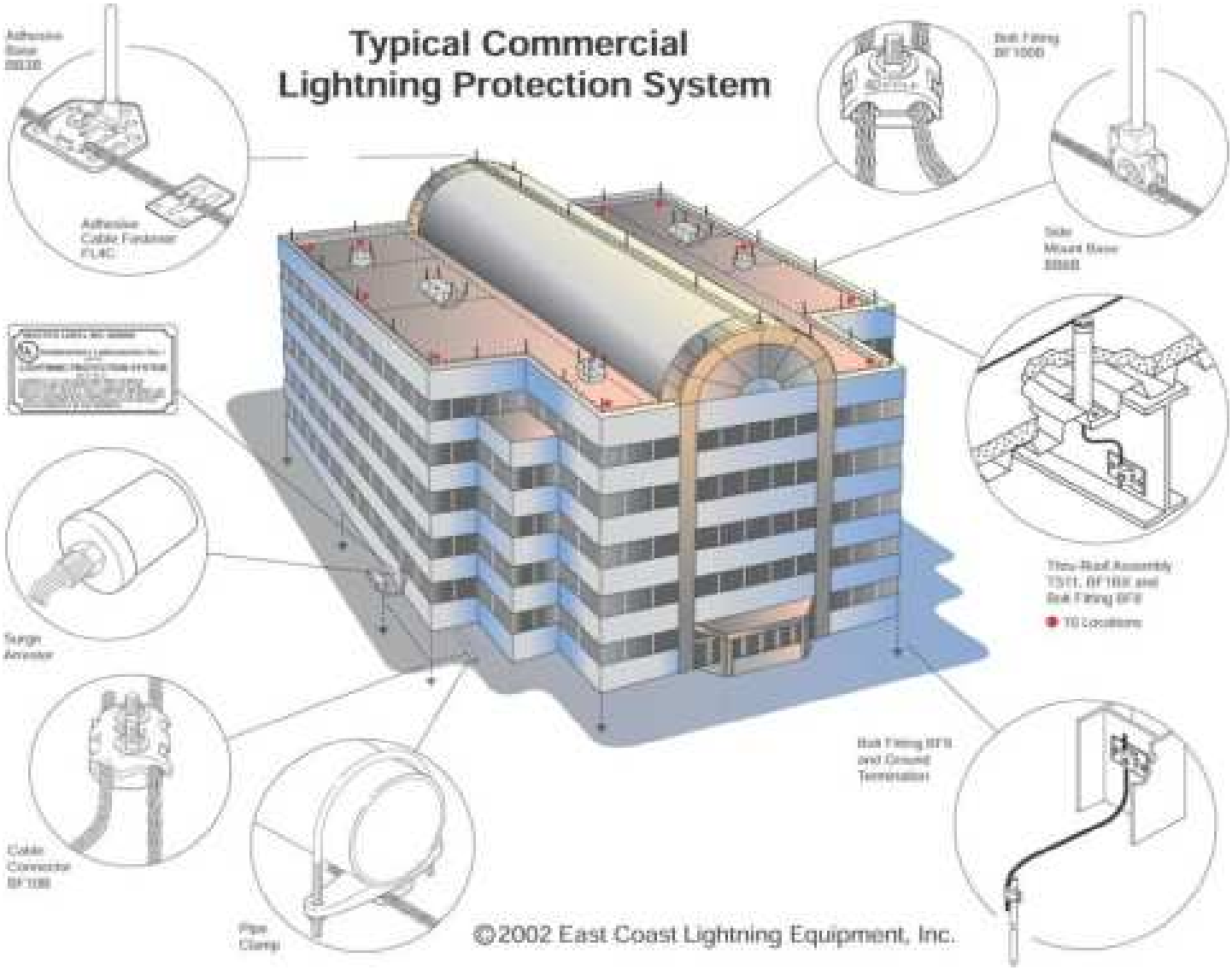
Static grounds: A static ground is a connection made between a piece of equipment and the earth for the purpose of draining off static electricity charges before a flash over potential is reached. This type grounding system is utilized in dry materials handling, flammable liquid pumps and delivery equipment, plastic piping, and explosive storage facilities.

System grounds: A system ground refers to the point in an electrical circuit that is connected to earth. This connection point is typically at the electrical neutral. The sole purpose of the system ground is to protect equipment. This type ground also provides a low impedance path for fault currents improving ground fault coordination. This ensures longer insulation life of motors, transformers and other system components.

Maintenance grounds: This type ground is utilized for safe work practices, and is a temporary ground.

Electronic and computer grounds: Grounding for electronic equipment is a special case in which the equipment ground and the system ground are combined and applied in unity. Electronic equipment grounding systems must not only provide a means of stabilizing input voltage levels, but also act as the zero (0) voltage reference point. Grounding systems for the modern electronics installation must be able to provide effective grounding and bonding functions well into the high frequency megahertz range.

Lightning protection: Lightning protection grounding requirements are dependent upon the structure, equipment to be protected, and the level of lightning protection required of desired.



1.15.5 - TYPES OF GROUNDING SYSTEMS

Ungrounded System:

The ungrounded system is one that has no intentional connection between the neutral or any phase and ground. Please note that an ungrounded system is grounded through the concept of capacitively coupling. The neutral potential of an ungrounded system, with balanced loading will be close to ground potential due to the capacitance between each phase conductor and ground.

Solidly Grounded System:

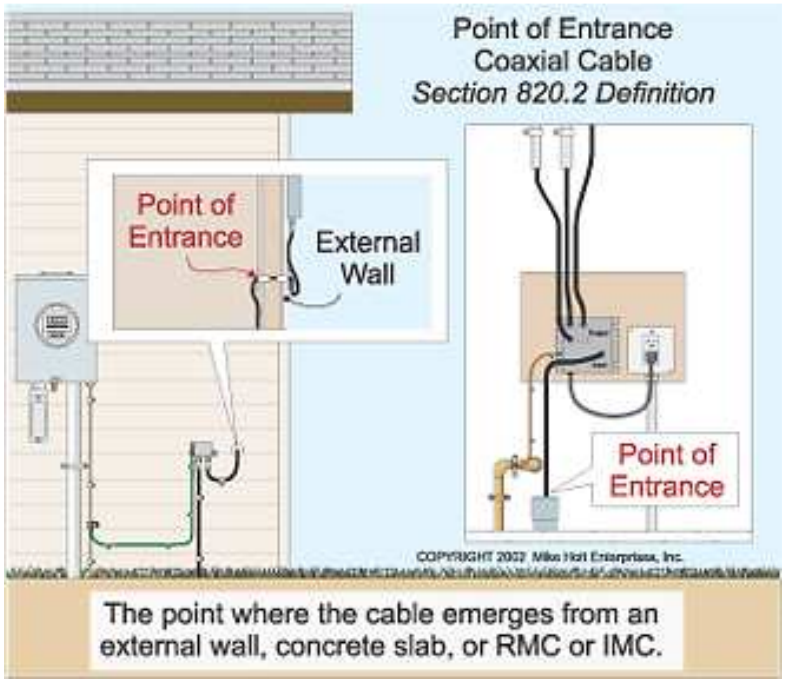
The solidly grounded system is one that has the neutral connected to ground without intentional impedance. In contrast to the ungrounded system the solidly grounded system will result in a large magnitude of current to flow (Aids in coordination), but has no increase in voltage on unfaulted phases.

Low Resistance Grounded System:

The low resistance grounded system is one that has the neutral connected to ground through a small resistance that limits the fault current. The size of the grounding resistor is selected to detect and clear the faulted circuit.

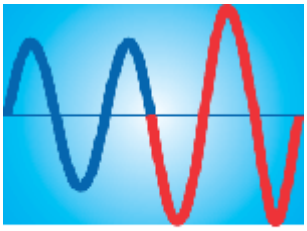
High Resistance Grounded System:

The high resistance grounded system is one that has the neutral connected to ground through a resistive impedance whose resistance is selected to allow a ground fault current through the resistor equal to or slightly more that the capacitive charging current of the system.



1.15.6 – IMPORTANT THINGS TO REMEMBER:

Over voltage



Whenever there is a lightning storm or line surges, basically anything that will cause higher voltage lines to come into contact can be very dangerous. You will find that grounding is something that is going to protect you from high voltages that can be very dangerous.

Stabilization

Basically, the ground is the most universal conductive surface. There are several different sources of electricity out there. Any different transformer that there is can actually be considered its own separate source. If there is not a common point of reference for these sources it is hard to try to calculate the relationship they have with each other.

Electrical cords

Used on a construction site must be able to pass a safety inspection. Cords that fail inspection must be taken out of use until they are repaired or replaced. Making sure that your cords are in good shape could be as important as preventing your home from burning.

Inspect Cord Ends

Check both ends carefully to make sure that they are not being pulled apart from the cord itself. If the outer sheath has been pulled back enough to see the insulated wires within, then the end needs to be replaced. Ordinary home cords don't have individually insulated wires inside and should be completely discarded at the first sign of being pulled apart at the end. If the cord is built to use a three prong plug, called a common ground, and then make sure that the third prong is still in place and hasn't been bent out of shape.

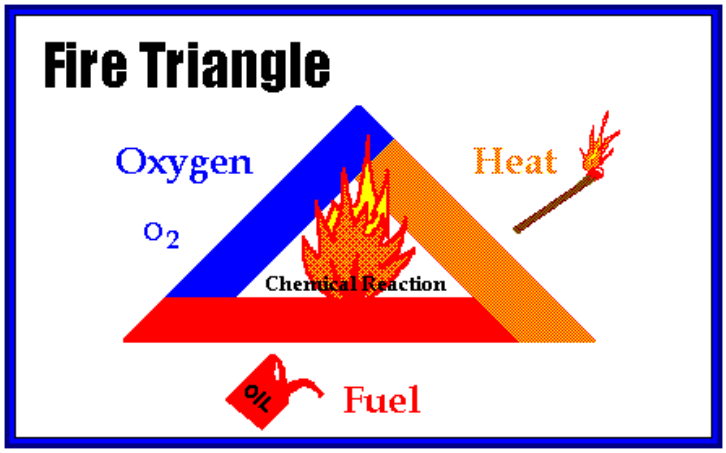
Don't Splice - Replace

Inspect the length of the cord for any places where the insulation is cut or compromised in some other way. In a work area, spliced cords are not allowed. If a cut in the insulation occurs, then the cord is no longer considered usable, for safety concerns. It is legal to splice a broken or damaged cord at home, but great care should be taken. The safest solution is to be following the rules for workers and replace any electrical cord which could cause a shock or fire hazard.

	Safety	**Module No.**	1.16
		Prepared by	M.Nasir
Course	Certificate in Engineering Skills	**Duration**	30 - Mins
Teaching Aid			
Topic	**Types and application of firefighting equipment**		

1.16 - TYPES AND APPLICATION OF FIREFIGHTING EQUIPMENT

1.16.1 - FIRE EXTINGUISHER



Fire safety, at its most basic, is based upon the principle of keeping fuel sources and ignition sources separate.

Three things must be present at the same time to produce fire:

1. Enough Oxygen to sustain combustion
2. Enough Heat to reach ignition temperature
3. Some Fuel or combustible material

Together, they produce the chemical reaction that is fire. Take away any of these things and the fire will be extinguished.

1.16.2 - FUEL CLASSIFICATIONS

Fires are classified according to the type of fuel that is burning. If you use the wrong type of extinguisher on the wrong class of fire, you might make matters worse. It is very important to understand the four different fire (fuel) classifications:

Class A: Wood, paper, cloth, trash, plastics—solids that are not metals.

Class B: Flammable liquids—gasoline, oil, grease, acetone. Includes flammable gases.

Class C: Electrical—energized electrical equipment. As long as it is "plugged in."

Class D: Metals—potassium, sodium, aluminum, magnesium. Requires Metal-X, foam, and other special extinguishing agents.

Most fire extinguishers will have a pictograph label telling you which types of fire the extinguisher is designed to fight.

For example, a simple water extinguisher might have a label like this, which means it should only be used on Class A fires.

1.16.3 - TYPES OF FIRE EXTINGUISHERS

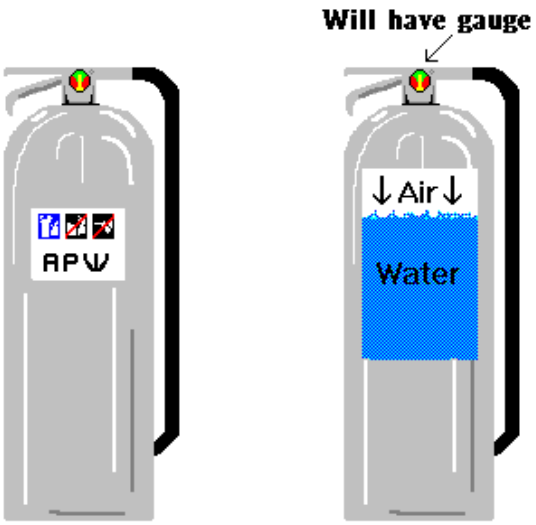
Different types of fire extinguishers are designed to fight different classes of fire. The three most common types of fire extinguishers are:

1. **Water (APW)**

Large, silver fire extinguishers that stand about 2 feet tall and weigh about 25 pounds when full.

APW stands for "Air-Pressurized Water."

Filled with ordinary tap water and pressurized air, they are essentially large squirt guns.



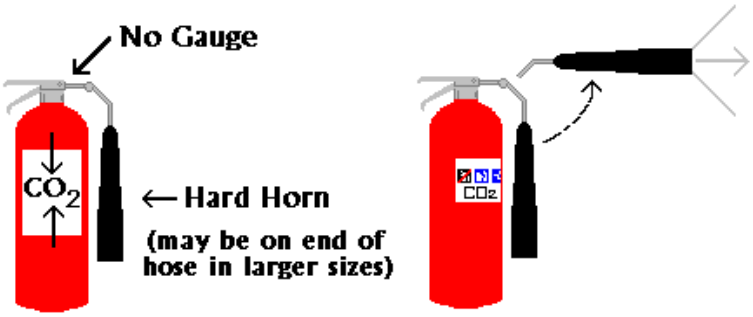
APW's extinguish fire by taking away the "Heat" element of the Fire Triangle.

APW's are designed for Class A fires **only**: Wood, paper, cloth. Here are a couple of reasons you need to be careful about which extinguisher you use:

- ⃠ Using water on a flammable liquid fire could cause the fire to spread.
- ⃠ Using water on an electrical fire increases the risk of electrocution. If you have no choice but to use an APW on an electrical fire, make sure the electrical equipment is unplugged or de-energized.

APW's will be found in older buildings, particularly in public hallways, as well as in residence halls on campus. They will also be found in computer laboratories. It is important to remember, however, that computer equipment must be disconnected from its electrical source before using a water extinguisher on it.

2. Carbon Dioxide (CO_2)



The pressure in a CO_2 extinguisher is so great, bits of dry ice might shoot out of the horn!

CO_2 cylinders are red. They range in size from 5 pounds to 100 pounds or larger. On larger sizes, the horn will be at the end of a long, flexible hose.

CO_2's are designed for Class B and C (flammable liquids and electrical sources) fires only!

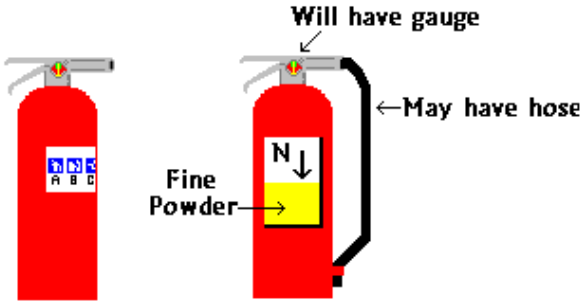
CO_2's will frequently be found in laboratories, mechanical rooms, kitchens, and flammable liquid storage areas.

In accordance with NFPA regulations (and manufacturers' recommendations) all CO_2 extinguishers at OSU undergo hydrostatic testing and recharge every five years.

Carbon dioxide is a non-flammable gas that takes away the oxygen element of the Fire Triangle. CO_2 is very cold as it comes out of the extinguisher, so it cools the fuel as well.

A CO_2 may <u>not</u> be very effective in extinguishing a Class A fire because it may not be able to displace enough oxygen to successfully put the fire out. Class A materials may also smolder and re-ignite.

3. Dry Chemical (ABC, BC, DC)



ABC extinguishers are red. On campus, they range in size from five pounds to 20 pounds.

On the OSU campus, ABC extinguishers are filled with a fine, yellow powder. This powder is mostly composed of monoammonium phosphate. The extinguishers are pressurized with nitrogen.

Dry chemical extinguishers put out fire by coating the fuel with a thin layer of dust. This separates the fuel from the oxygen in the air. The powder also works to interrupt the chemical reaction of fire. These extinguishers are very effective at putting out fire.

Dry chemical extinguishers come in a variety of types. You may see them labeled:

- DC (for dry chemical)
- ABC (can be used on Class A, B, or C fires)
- BC (designed for use on Class B and C fires)

It is extremely important to identify which types of dry chemical fire extinguishers are located in your area!

An "ABC" extinguisher will have a label like this, indicating it may be used on Class A, B, and C fires.

You don't want to mistakenly use a "BC" extinguisher on a Class A fire thinking that it was an "ABC" extinguisher.

Dry chemical extinguishers with powder designed for Class B and C fires ("BC" extinguishers) may be located in places such as commercial kitchens and areas with flammable liquids.

On campus you will find ABC's in public hallways of new buildings, in laboratories, break rooms, offices, chemical storage areas, mechanical rooms, University vehicles, etc.

1.16.4 - HOW TO USE A FIRE EXTINGUISHER

It is easy to remember how to use a fire extinguisher if you remember the acronym, "PASS."

Pull

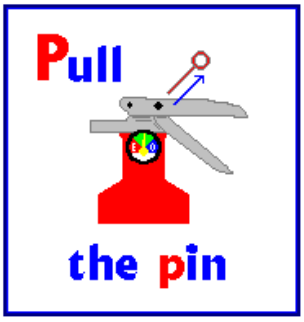
Aim

Squeeze

Sweep

Pull the pin

This will allow you to discharge the extinguisher.



Aim at the base of the fire

Hit the fuel…if you aim at the flames, the extinguishing agent will pass right through and do no good.

Squeeze the top handle

This depresses a button that releases the pressurized extinguishing agent.

Sweep from side-to-side until the fire is completely out.

Start using the extinguisher from a safe distance away and then slowly move forward. Once the fire is out, keep an eye on the area in case it re-ignites.

1.16.5 - RULES FOR FIGHTING FIRES

Fires can be very dangerous and you should always be certain that you will not endanger yourself or others when attempting to put out a fire. For this reason, when a fire is discovered,

1. Assist any person in immediate danger to safety, if it can be accomplished without risk to yourself.

2. Call 911 or activate the building fire alarm. The fire alarm will notify the fire department as well as other building occupants and shut off the air handling system to prevent the spread of smoke.

If the fire is small (and Only after having done these two things), you may attempt to use an extinguisher to put it out.

However, before deciding to fight the fire, keep these things in mind:

- **Know what is burning**. If you don't know what is burning, you won't know what kind of extinguisher to use.
- Even if you have an ABC fire extinguisher, there might be something in the fire that is going to explode or produce toxic fumes.

  Chances are you will know what is burning, or at least have a pretty good idea, but if you don't, let the fire department handle it.
- Is the fire spreading rapidly beyond the point where it started? The time to use an extinguisher is at the beginning stages of the fire.
- If the fire is already spreading quickly, it is best to simply evacuate the building.

As you evacuate a building, close doors and windows behind you as you leave.

This will help to slow the spread of smoke and fire.

Do not fight the fire if:

- <u>You don't have adequate or appropriate equipment.</u>
  If you don't have the correct type or large enough extinguisher, it is best not to try fighting the fire.
- <u>You might inhale toxic smoke.</u>
  When synthetic materials such as the nylon in carpeting or foam padding in a sofa burn, they can produce hydrogen cyanide, acrolein, and ammonia in addition to carbon monoxide. These gases can be fatal in very small amounts.
- <u>Your instincts tell you not to.</u>
  If you are uncomfortable with the situation for any reason, just let the fire department do their job.

The final rule is to always position yourself with an exit or means of escape at your back before you attempt to use an extinguisher to put out a fire.

In case the extinguisher malfunctions, or something unexpected happens, you need to be able to get out quickly. You don't want to become trapped.

FIRE HOSE REELS ARE USE'

TO COVER DISTANCE,AND CONNECT WITH FIRE VEHICLE PUMP OR FIRE WATER PRESSURE LINES.

	Safety	**Module No.**	1.17
		Prepared by	S.Fawad Ashraf
Course	Certificate in Engineering Skills	**Duration**	15 - Mins
Teaching Aid			
Topic	**Explain the need for evacuation procedures.**		

1.17 - EXPLAIN THE NEED FOR EVACUATION PROCEDURES.

1.17.1 - REPORTING AN EMERGENCY

- Time is *critical*
- Report emergencies rapidly
- Know the procedures for your building
- Use the best available means of communication

1.17.2 - THERE IS A FIRE WHAT DO I DO?

- Upon discovering a fire, immediately sound the building fire alarm and/or alert other occupants. Only properly trained emergency response personnel should assist with the evacuation of mobility-impaired individuals.
- From outside of the building dial emergency number.
- Provide your name, which building you are in, and the location of the fire.

1.17.3 - EVACUATION PROCEDURES

- Recognize the emergency evacuation signal (fire alarm) and listen for instructions
- Shut down equipment using the emergency stop and/or main electrical disconnect
- Direct and assist students and staff to the nearest safe exit
- Proceed to the assembly area
- Use your class roster and perform a head count
- Report any un-accounted for students or staff members
- When you evacuate, do not stop for personal belongings. Leave immediately using the nearest exit. Do not use the elevators.
- Evacuate to the designated meeting location for the building and out of the way of emergency personnel.

1.17.4 - RACE METHOD OF EVACUATION

- **R** Remove all persons in danger!
- **A** Always pull the alarm and call ECU Police Department.
- **C** Contain the fire by closing the windows and doors.
- **E** Extinguish the fire only if you are trained and confident.

1.17.5 - BUILDING EVACUATION

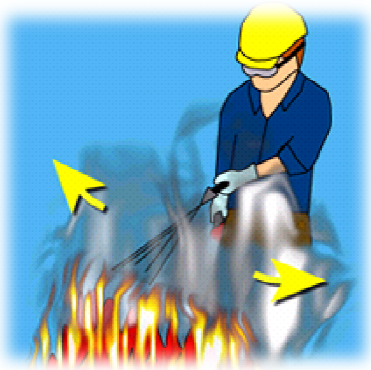
- Proceed to nearest exit in an orderly fashion.
- Assemble at least 100 feet from the building at your designated meeting location.
- Provide emergency crews with information about people still in the building.
- Never re-enter a building until instructed to by the police department, fire department, or EH&S staff.

Incipient Stage Fires

Fires in the initial or beginning stage and can be controlled or extinguished by portable fire extinguishers without the need for protective clothing or breathing apparatus.

1.17.6 - HOW TO USE AN EXTINGUISHER

P A S S



P: Pull the pin.

A: Aim extinguisher nozzle at the base of the flame.

S: Squeeze trigger while holding the extinguisher upright.

S: Sweep the extinguisher from side to side, covering the area with the extinguishing agent.

Is It Ready To Use?

- Visually inspected monthly
- Maintained annually
- Hydrostatically tested periodically (5 or 12 yrs.)

When NOT to Fight a Fire!

- Only fight a fire in the incipient stage
- Fire has spread beyond its point of origin
- Your instincts tell you GET OUT
- Remember to keep an exit to your back

Do You Know???

- Where is the nearest fire alarm station?
- Where is the nearest fire extinguisher?
- Where is the primary exit?
- Where is the secondary exit?
- Where is your emergency procedures manual?

1.18 - SAFETY MEASURES WHEN WORKING WITH THE TOXIC THINGS

1.18.1 - PRECAUTIONS

1. CONDUCT PROCEDURES IN A FUME HOOD, glove box, other suitable containment device.
2. Become thoroughly familiar with the toxicology of the chemicals you work with. Refer to SOPs and MSDSs whenever necessary.
3. All people working in the area should be familiar with the hazards of the experiment and the appropriate emergency response procedures.
4. After using toxic materials the laboratory worker should wash his or her face, hands, neck and arms.
5. Equipment used for handling highly toxic chemicals should be suitably isolated from the general laboratory environment. Laboratory vacuum pumps used with these substances should be outfitted with cold traps and/or high-efficiency scrubbers and vented into an exhaust hood.
6. Equipment and PPE that come in contact with toxic/highly toxic materials must be thoroughly cleaned.
7. Minimize the quantity of toxicants stored in the work area.

1.18.2 - WHY SHOULD I WORK SAFELY WITH VERY TOXIC MATERIALS?

Very Toxic materials are substances that may cause serious harm to an individual if it enters the body. This document provides guidance on safe handling and storage practices and how to work safely with very toxic materials.

1.18.3 - WHY SHOULD I SUBSTITUTE WITH A LESS HAZARDOUS MATERIAL WHERE POSSIBLE?

Whenever possible, it is always best to avoid using a very toxic material either by eliminating its use (by changing the method or process for example) or by substituting the very toxic material with a less hazardous material. Unfortunately, it is not always possible to find a non-toxic (or less toxic) substitute that still does the job effectively and safely.

When considering substitution, the first step is to obtain the Material Safety Data Sheets (MSDSs) for all possible substitute materials. Find out about all of the hazards (health, fire, chemical reactivity) of these materials before making any changes. Caution must be exercised so as to avoid introducing a potentially more hazardous situation. Choose the least hazardous materials that can do the job effectively and safely. Learn how to work safely with them, too.

1.18.4 - WHY SHOULD I USE GOOD VENTILATION WHENEVER WORKING WITH VERY TOXIC MATERIALS?

To prevent exposure to a very toxic material, strict control measures are required. Ventilation is a very important control measure for very toxic materials. Well-designed and well-maintained ventilation systems remove the very toxic vapors, fumes, mists or airborne dusts from the workplace before workers are exposed.

When considering exposure control measures such as ventilation, there are many considerations, including:

An assessment of the specific ways that a very toxic material is stored, handled, used, and disposed of is the best way to find out if existing ventilation controls (and other hazard control methods) are adequate.

Generally, with very toxic materials, general (dilution) ventilation does not provide sufficient protection. To prevent a very toxic material from entering the workplace, local exhaust systems are usually required. For larger scale operations, this may require designing the process so that the very toxic material is completely enclosed or isolated from the workplace environment. In other situations, where smaller amounts are used, glovebox isolation units or local exhaust systems are used. Leak detection systems with alarms may be desirable for some situations.

For any of these ventilation systems, particularly ones that deal with very toxic materials, it is important to ensure that:

- Contaminated air does not allow back into the workspace;
- There is some means of indicating if there is a failure of the system (e.g., alarm system if airflow is compromised);
- Users know how to respond during an emergency or ventilation system failure; and
- The protective systems (e.g. ventilation, alarms, etc.) are regularly inspected and maintained by trained individuals who understand the potential hazards and are suitably protected.

1.18.5 - HOW SHOULD I STORE CONTAINERS OF VERY TOXIC MATERIALS?

For the storage of very toxic materials, ensure that the storage area is clearly identified with warning signs, is clear of obstructions and is accessible only to trained and authorized personnel.

Before storing very toxic materials, inspect all incoming containers to ensure that the containers are undamaged and are properly labeled. Do not accept delivery of defective containers. Also, be sure to store very toxic materials in the type of containers recommended by the manufacturer or supplier.

Some other important points for storage of very toxic materials include:

- Keep the amount of very toxic material in storage as small as possible (generally no more than 3 months worth).
- Inspect storage areas and containers regularly for any deficiencies, including leaking or damaged containers, expired shelf-life or poor housekeeping. Correct all deficiencies immediately.
- Ensure that containers are tightly closed when not in use and when empty. Keep empty containers in a separate storage area. Assume empty containers contain hazardous toxic residue and keep tightly closed.
- Store containers at a convenient height for handling, below eye level if possible. High shelving increases the risk of dropping containers and the severity of damage, injury and/or exposure if a fall occurs.
- Store material within the temperature range recommended by the chemical manufacturer/supplier.

- To contain spills or leaks, store containers of very toxic materials in trays made of compatible materials. For larger containers such as drums or barrels, provide dikes around the storage area and sills or ramps at door openings. Storage tanks should be above ground and surrounded with a dike capable of holding the entire contents.

1.18.6 - WHERE SHOULD VERY TOXIC MATERIALS BE STORED?

Very toxic materials must be stored in an appropriate storage area and location. In general, the storage area for very toxic materials should have the following characteristics. Many of these recommendations apply for safe chemical storage in general.

- Ensure that the storage area is well-ventilated and out of direct sunlight.
- Store very toxics separately, away from processing and handling areas, eating areas and protective equipment storage. Separate storage reduces the amount of damage and/or injury caused in case of fires, spills or leaks. If totally separate storage is not possible, use physical separation to keep very toxics away from incompatible materials.
- The storage area should be fire-resistant and constructed from non-combustible materials.
- Ensure that emergency eyewash/shower stations are readily available nearby and are tested regularly.
- Ensure that suitable fire extinguishers and spill clean-up equipment are available.

1.18.7 - HOW DO I HANDLE VERY TOXIC MATERIALS SAFELY?

Safe handling and work procedures are crucial for workplaces where individuals use very toxic materials. It is vital that people working with hazardous materials such as very toxics are properly trained regarding the potential hazards. Remember, if, at any time an individual is unsure or has questions about working with a very toxic material, they should always talk with the supervisor.

This section **refers** to general safe handling practices for very toxic materials. Instructions and training for the **specific** handling of a particular very toxic material used a workplace is the responsibility of the supervisor (employer).

In general, when handling very toxic materials:

- Before handling, it is extremely important that engineering controls are operating properly and that required protective equipment requirements and personal hygiene measures are being followed.
- Consider using a closed handling system for processes involving a very toxic material. If a closed handling system is not possible, use the smallest possible amounts in a well-ventilated area separate from the storage area.
- Prevent the release of very toxic vapors, dusts, mists or gases into the workplace air.
- Maintenance and emergency personnel need to be advised of potential hazards.
- Immediately report any leaks, spills or failures of the engineering controls.
- Wear appropriate personal protective equipment to avoid exposure (eye, respiratory or skin) or contact with contaminated equipment/surfaces.
- Never work alone with very toxic materials. Another person must be in view at all times and must be equipped and trained to rescue. Alternatively, precautions such as regular visual checks made by another person or a telephone call-in procedure should be set up to ensure the continued safety of lone workers or workers in remote locations.
- Be alert to the typical symptoms of poisoning and first aid procedures. Report any signs of illness or overexposure immediately to the supervisor. Depending on the material, medical attention for an exposure may be required even if the exposure did not seem excessive. With some materials, symptoms of a severe exposure can be delayed.
- Do not return contaminated or unused material to the original container.

- Ensure containers are clearly labeled and inspect containers for leaks or damage before handling.
- Keep containers tightly closed when not in use.
- To prevent spillage, use proper tools to open containers and to transfer material.
- Pour very toxic liquids carefully from the container to avoid splashing and spurting.
- Maintain good housekeeping (e.g. clean surfaces, no accumulation of dust).
- Avoid any welding, cutting, soldering or other hot work on an empty container or piping until all very toxic liquid and vapors have been cleared.
- For large-scale storage of this material consider the installation of a leak detection system with an alarm.
- Ensure suitable emergency equipment for fires, spills and leaks are readily available.
- In the event of a spill or leak of a very toxic material, evacuate the work space.
- Ensure emergency eyewash/shower stations are readily available and are tested regularly.

1.18.8 - HOW DO I DISPOSE OF VERY TOXIC WASTE MATERIAL SAFELY?

Very toxic waste material must be disposed of properly. Careless disposal of any hazardous waste presents a potential hazard to many individuals who may not be trained or equipped to deal with unexpected hazardous materials (e.g. caretaking staff, garbage collectors, plumbers, water treatment plant workers, firefighters, etc.). Careless disposal can also cause significant damage to the environment.

The following are some general recommendations for disposal of very toxic waste materials:

- Always review federal, provincial and local (municipal) government requirements prior to disposal of very toxic materials. In some cases, disposal by controlled incineration or secure landfill may be acceptable. Specific requirements may vary depending on the jurisdiction.
- Very toxic chemical waste must NOT be flushed down sewer or sanitary drains as a method of disposal. This practice is illegal and unsafe.
- Do not mix hazardous waste materials with regular garbage destined for a landfill.
- Ensure that the waste container used is compatible with the waste material.
- Always ensure that the waste container is properly and accurately labeled.
- To avoid potential explosions, fires or spills, do not mix incompatible mixtures in a single waste container.
- Do not overfill liquid waste containers. Liquid waste containers should only be filled to about three-quarters capacity to allow for vapor expansion and to reduce the potential for spills occurring from moving overfilled containers.
- In general, store waste material in the same manner as the non-waste material. Always consult the MSDS for any specific storage and disposal recommendations from the manufacturer/supplier.
- Assume that empty containers contain very toxic residues. Do not reuse the containers. Treat the container as hazardous waste unless the containers can be decontaminated safely and properly.

1.18.9 - WHY IS PERSONAL CLEANLINESS IMPORTANT WHEN WORKING WITH VERY TOXIC MATERIALS?

Personal cleanliness when working with very toxic materials provides protection not only for you but protects others as well (such as co-workers and family members).

- Maintain good personal hygiene. Wash hands before eating, drinking, smoking or going to the toilet. When handling on a large scale, a double locker-shower set-up may be necessary.
- Remove contaminated clothing and leather shoes or boots. Wash contaminated items immediately and thoroughly in water before re-wearing or discarding.
- Store food and tobacco products in uncontaminated areas.
- Avoid touching yourself (e.g. scratching your nose or rubbing your eyes) with contaminated hands.
- Do not chew gum when working with very toxic materials.
- Wash thoroughly at the end of the workday even though you have done everything mentioned above.

1.18.10 - WHEN SHOULD I WEAR PROPER PERSONAL PROTECTIVE EQUIPMENT?

Control measures such as ventilation, enclosure and work practices are examples of the preferred methods of protecting workers. If these measures are not feasible or unable to provide appropriate worker protection, then personal protective equipment may be required.

Choosing the right PPE for a particular job is essential. MSDSs should provide general guidance. Also obtain help from a qualified professional who knows how to evaluate the hazards of a specific job, especially those related to very toxic materials, and how to select the proper PPE.

Before a very toxic material is brought into the building and used:

- The appropriate PPE should be selected and be available.
- Workers should know where the PPE is and be trained to use it for emergencies as well as for normal operations.
- It is important to understand the limits of PPE, not just its capabilities.

 The Personal Protective Equipment Section of OSH Answers has several question-and-answer documents on PPE programs including the selection, use and maintenance of various kinds of PPE.

It is crucial that any required PPE be worn when specified for a job. PPE can be very effective **but not if you don't wear it.**

1.18.11 - AVOIDING SKIN CONTACT WITH VERY TOXIC MATERIALS

Some very toxic materials can be harmful through skin contact. In these instances, it may be necessary to wear protective equipment such as gloves, aprons, boots, hoods or other clothing, depending on the risk of skin contact. Choose clothing made of materials that resist permeation, penetration or damage by the chemical. The Chemical Protective Clothing OSH Answers has general information on selecting gloves and other chemical protective clothing. The MSDS should recommend appropriate materials. If it does not, contact the chemical supplier for specific information.

1.18.12 - PROTECTING THE EYES AND FACE FROM VERY TOXIC MATERIALS

Eye protection is important when working with very toxic materials. Selection of the most appropriate type depends on factors such as how the material is used, physical characteristics (e.g. fine powder, liquid, vapor, etc.) and potential health effects (e.g. eye irritant, skin irritant, toxicity through skin absorption, etc.). In some cases, it may be necessary to wear a face shield to protect the face from splashes. The Safety Glasses OSH Answers has information on selecting PPE for protecting the eyes and face. The current Canadian Standards Association (CSA) Standard Z94.3 "Industrial Eye and Face Protectors," provides additional advice on selection and use of eye and face protectors.

1.18.13 - AVOID BREATHING VERY TOXIC DUSTS, MISTS OR VAPORS

Proper selection and fitting of respiratory protection can be quite complex and any time it is used in a workplace, it must be carefully monitored and controlled to ensure worker safety.

If respiratory protection is required in the workplace, a respiratory protection program must be developed, written and maintained as described in the Respirator Selection OSH Answers. Further guidance for developing a program can be found "Selection, Care, and Use of Respirators." Follow all legal requirements for respirator use and approvals. These may vary between jurisdictions in Canada.

Careful selection of the appropriate respirator style and cartridges is an important component of any respiratory protection program. Respiratory equipment must be properly sized and the user must know how to fit-test, clean, maintain and store the equipment. Users must also know how often to change the cartridges. NEVER assume that "smelling" the very toxic material will indicate when to change the cartridge.

1.18.14 - WHAT SHOULD I DO IN AN EMERGENCY?

The time to figure out what to do during an emergency is BEFORE it happens. Be ready to handle emergencies such as fire, leaks or spills quickly and safely.

In the event of an emergency involving a very toxic material:

- In the event of a spill or release of a very toxic material, immediately put on a suitable respirator and leave the area until the severity of the problem is determined. Escape-type respiratory protective equipment should be readily available in the work area.
- Report any leaks, spills or ventilation failures immediately. Restrict access to the affected area.

- Obtain first aid if you have been exposed to the very toxic material.
- Ensure emergency eyewash stations and safety showers are present wherever accidental exposure to very toxic materials might occur.
- In the event of skin or eye contact, the first aid response usually involves flooding the contaminated area with large amounts of water. The specific first aid recommendations can vary from one very toxic material to another, however, depending on the nature (properties and hazards) of the material.
- The MSDS and container label for a particular very toxic material should give specific first aid instructions in case of exposure by skin or eye contact, inhalation, or swallowing.
- Time is crucial if an individual is exposed to a very toxic material. Ensure that an appropriate emergency medical response is planned and prepared in advance – this may include stocking the antidote or drugs required for treatment, having written procedures (and MSDS) as well as cautions available for the emergency personnel.
- Only specially trained people, equipped with the proper tools and protective equipment, should handle the emergency. Nobody else should go near the area until it is declared safe.
- Planning, training and practicing for emergencies are important so that everyone knows what they must do.
- It may be necessary to notify government environmental agencies if there is a release of very toxic material into the environment.

The MSDSs for the materials being used on the job are a good starting point for creating an emergency plan. MSDSs have specific sections on toxicity, fire and explosion hazards, including suitable fire extinguishing equipment and methods, spill clean-up procedures and first aid instructions. If the directions in each MSDS section are not clear or seem incomplete, contact the material's manufacturer or supplier for help. You can obtain help in developing emergency plans from many other sources too. Local fire departments can assist with fire emergency plans and training. Occupational health and safety and environmental enforcement agencies, provincial safety associations, St. John Ambulance, insurance carriers, professional societies in occupational health and safety, labour unions, trade associations, some local colleges and universities, and CCOHS can supply useful information at little or no cost.

1.18.15 - WHAT ARE THE BASIC SAFETY PROCEDURES CONCERNING VERY TOXIC MATERIALS?

Following these basic safe practices will help protect you from the hazards of very toxic materials:

- Know which materials you work with are very toxic. In addition, be aware of ALL of the hazards (e.g. fire/explosion, corrosion, chemical reactivity) of the materials used in your work.
- Read the MSDSs for all of the materials used in your work. Know how to use these materials safely and be able to protect yourself and your co-workers.
- Follow the work practices specified by your employer. Your employer must provide specific training on how to work safely with these materials at your worksite.
- Store, handle and use very toxic materials only in well-ventilated areas.
- Ensure that engineering controls (e.g. ventilation) are operating. Closed handling systems may be necessary to prevent the release of the material (dust, mist, vapor, gas) into the workplace.
- Report ventilation failures, leaks or spills to your supervisor immediately.
- Wear the appropriate personal protective equipment that your employer specifies for the job. This equipment may include respiratory protection, goggles, face shield, and chemical protective clothing, such as an apron and gloves made from materials that protect against the chemicals being handled.
- Be aware of the typical symptoms of an overexposure and appropriate first aid procedures. Report any signs of illness immediately to your supervisor.

- Keep containers tightly closed when not in use.
- Keep only the smallest amounts possible (not more than one day's supply) in the work area.
- Do not return contaminated or unused material back to the original container.
- Practice good housekeeping, personal cleanliness and proper equipment maintenance.
- Handle and dispose of very toxic wastes safely.
- Know how to handle emergencies (fires, spills, personal injury) involving the very toxic materials you work with.
- Follow the health and safety rules that apply to your job.

I am going to give you some tips and techniques on welding safety. One of the things that a welder needs to be aware of is that the fumes that come off of the welding arc can sometimes be toxic. A welder needs to be very careful about what he welds on. For instance, welding on old painted steel can pose a problem if the paint was lead based. The smoke will contain vaporized lead and can cause lead poisoning. Inhaling it can be very toxic to a welder. Also welding on some of the newer types of paints chromium paints, chromate paints can also cause toxic fumes. Something that is very important is that a welder should never weld on galvanized steel unless you grind the galvanize off; you can get a poisoning from it called fume fever. What happens is the zinc boils out of the galvanize, comes up into the air as a zinc gas, you inhale it and it can make you feel very sick. It is almost a like a bad case of flu. So be very careful about that. Try to ventilate the fumes away from you or wear the appropriate mask. Welding fumes as a whole are not dreadfully toxic but they can become very concentrated in closed areas. It is best to have a supply of fresh air if you can, fans, blowers etc. Try to get the fumes out of the area, supply fresh air to yourself or wear the appropriate breathing masks under your helmet. There are some that are available to try and to and limit your exposure so that you do not end up making yourself sick."

1.19 - PRECAUTION FOR PRESSURE TESTING

If pressure equipment fails in use, it can seriously injure or kill people nearby and Cause serious damage to property. Each year in Great Britain, there is about 150 dangerous occurrences involving such unintentional releases. Around six of these Result in fatal or serious injury.

This leaflet advises you how to minimize the risks when working with systems or Equipment which contain a liquid or gas under pressure. It does not cover gas Cylinders (now called transportable pressure receptacles or transportable pressure Vessels), or tanks and tank containers.

As an employer or self-employed person, you have a duty to provide a safe workplace and safe work equipment. Designers, manufacturers, suppliers, installers, users and owners also have duties. The main regulations covering pressure equipment and pressure systems are the Pressure Equipment Regulations 1999 and the Pressure Systems Safety Regulations 2000. Employers have a further duty to consult any safety or employee representatives on health and safety matters. Where none are appointed, employers should consult the workforce dire

1.19.1 - EXAMPLES OF PRESSURE SYSTEMS AND EQUIPMENT ARE:

1. boilers and steam heating systems;
2. pressurized process plant and piping;
3. compressed air systems (fixed and portable);
4. pressure cookers, autoclaves and retorts;
5. heat exchangers and refrigeration plant;
6. valves, steam traps and filters;
7. pipe work and hoses; and
8. pressure gauges and level indicator

1.19.2 - PRINCIPAL CAUSES OF INCIDENTS ARE

1. poor equipment and/or system design;
2. poor maintenance of equipment;
3. an unsafe system of work;
4. operator error, poor training/supervision;
5. poor installation; and
6. Inadequate repairs or modifications.

1.19.3 - THE MAIN HAZARDS ARE

1. impact from the blast of an explosion or release of compressed liquid or gas;
2. impact from parts of equipment that fail or any flying debris;
3. contact with the released liquid or gas, such as steam; and
4. fire resulting from the escape of flammable liquids or gases

1.19.4 - REDUCE THE RISK OF FAILURE

The level of risk from the failure of pressure systems and equipment depends on a number of factors including.

1. The pressure in the system;
2. The type of liquid or gas and its properties;
3. The suitability of the equipment and pipework that contains it;
4. The age and condition of the equipment;
5. The complexity and control of its operation;
6. The prevailing conditions (e.g. a process carried out at high temperature); and
7. The skills and knowledge of the people, who design, manufacture, install, maintain, test and operate the pressure equipment and systems.

To reduce the risks you need to know (and act on) some basic precautions, some of which are contained in the Pressure Systems Safety Regulations 2000 and the Pressure Equipment Regulations 1999.

1.19.5 - PROVIDE SAFE AND SUITABLE EQUIPMENT

1. When installing new equipment, ensure that it is suitable for its intended purpose and that it is installed correctly. This requirement can normally be met by using the appropriate design, construction and installation standards and/or codes of practice. From 30 May 2002, most pressure equipment placed on the market must meet the requirements of the Pressure Equipment Regulations 1999. For pressure equipment not covered by the Pressure Equipment Regulations 1999, the more general requirements of the Pressure Systems Safety Regulations 2000 apply.
2 The pressure system should be designed and manufactured from suitable materials. You should make sure that the vessel, pipes and valves have been made of suitable materials for the liquids or gases they will contain.
3 Ensure the system can be operated safely - without having to climb or struggle through gaps in pipe work or structures, for example.
4 Be careful when repairing or modifying a pressure system. Following a major repair and/or modification, you may need to have the whole system re-examined before allowing the system to come back into use

1.19.6 - KNOW THE OPERATING CONDITION.

1. Know what liquid or gas is being contained, stored or processed (e.g. is it toxic/flammable?).
2. Know the process conditions, such as the pressures and temperatures.
3. Know the safe operating limits of the system and any equipment directly linked to it or affected by it.
4. Ensure there is a set of operating instructions for all the equipment and for the control of the whole system including emergencies.
5. Ensure that appropriate employees have access to these instructions, and are properly trained in the operation and use of the equipment or system (see the section on training)

1.19.7 - FIT SUITABLE PROTECTIVE DEVICES AND ENSURE THEY FUNCTION PROPERLY

1. Ensure suitable protective devices are fitted to the vessels, or pipe work (eg safety valves and any electronic devices which cause shutdown when the pressure, temperature or liquid or gas level exceed permissible limits).
2. Ensure the protective devices have been adjusted to the correct settings.
3. If warning devices are fitted, ensure they are noticeable, either by sight or sound.
4. Ensure protective devices are kept in good working order at all times.3 of 5 pagesPressure systems - safety and you
5. Ensure that, where fitted, protective devices such as safety valves and bursting discs discharge to a safe place.
6. Ensure that, once set, protective devices cannot be altered except by an authorized person.

1.19.8 - CARRY OUT SUITABLE MAINTENANCE

1. All pressure equipment and systems should be properly maintained. There should be a maintenance programmed for the system as a whole. It should take into account the system and equipment age, its uses and the environment.
2. Look for tell-tale signs of problems with the system, e.g. if a safety valve repeatedly discharges, this could be an indication that either the system is over pressurizing or the safety valve is not working correctly.
3. Look for signs of wear and corrosion.
4. Systems should be depressurized before maintenance work is carried out.
5. Ensure there is a safe system of work, so that maintenance work is carried out properly and under suitable supervision

1.19.9 - MAKE PROVISION FOR APPROPRIATE TRAINING

Everybody operating, installing, maintaining, repairing, inspecting and testing pressure equipment should have the necessary skills and knowledge to carry out their job safely - so you need to provide suitable training. This includes all new employees, who should have initial training and be supervised closely. Additional training or retraining may be required if:

1. The job changes;
2. The equipment or operation changes; or
3. Skills have not been used for a while

1.19.10 - HAVE THE EQUIPMENT EXAMINE

Under the Pressure Systems Safety Regulations 2000, a written scheme of examination is required for most pressure systems. Exempted systems are listed in the Regulations. Generally speaking, only very small systems are exempted.

1. The written scheme should be drawn up (or certified as suitable) by a competent person. It is the duty of the user of an installed system and the owner of a mobile system to ensure that the scheme has been drawn up. You must not allow your pressure system to be operated (or hired out) until you have a written scheme of examination and ensured that the system has been examined.
2. The written scheme of examination must cover all protective devices. It must also include every pressure vessel and those parts of pipelines and pipe work which, if they fail, may give rise to danger.
3. The written scheme must specify the nature and frequency of examinations, and include any special measures that may be needed to prepare a system for a safe examination.
4. The pressure system must be examined in accordance with the written scheme by a competent person.
5. For fired (heated) pressure systems, such as steam boilers, the written scheme should include an examination of the system when it is cold and stripped down and when it is running under normal conditions.

The key steps are

1. Decide what items of equipment and parts of the plant should be included in the scheme. This must include all protective devices. It must also include pressure vessels, and parts of pipe work, which if they failed could give rise to danger.
2. The scheme must be drawn up (or certified as suitable) by a competent person. It must specify whether the examination is in-service or out-of service and how often the system is to be examined.
3. The system must be examined by a competent person in accordance with that scheme.

1.19.11 - CHOOSE A COMPETENT PERSON

1. You must assure yourself that the competent person has the necessary knowledge, experience and independence to undertake the functions required of them.
2. The competent person carrying out examinations under a written scheme does not necessarily need to be the same one who prepares or certifies the scheme as suitable.

A competent person may be

1. A company's own in-house inspection department;
2. An individual person (e.g., a self-employed person); or
3. An organization providing independent inspection services.

1.19.12 - LEAK OR TIGHTNESS TEST FOR WELDS

Leak refers to an actual discontinuity or passage through which a fluid flows or permeates. Leak testing is the determination of the rate at which a liquid or gas will penetrate from inside a tight component or assembly to the outside as a result of pressure differential between the two regions.

Purpose

To test welded pressure vessels, tanks and pipelines to determine if leaks are present. Absolute tightness of all the welded joints can be tested this way.

Procedure

The welded vessel, after closing all its outlets, is subjected to internal pressure using water, oil, air or gas (e.g. CO_2). Hydraulic pressure, using water as the fluid, is the usual medium employed in this test.

Oil if it is thin/hot will penetrate leaks that do not show up with water under an equal pressure. Air will leak out more readily than water and gas (e.g. Hydrogen) will escape where air will not.

Where feasible, it is better to use water or oil because there will be very less tendency for the parts to be violently thrown out in case of a sudden release of pressure. When using air/gas, failure of vessel can cause injuries to persons around.

The internal pressure may be raised to two times the working pressure. When under pressure, the weld may be tested as follows for detecting the leak:

(i) Pressure on the gauge may be noted immediately after applying the internal pressure and after, say, 12 to 24 hours. Any drop in pressure reading indicates a leak.

(ii) After generating air pressure in the vessel, soap solution may be painted on the weld seam and carefully inspected for bubbles which would indicate leak.

(iii) The welded surface is coated with a lime solution. After the lime has dried, pressure is built up in the vessel. Where the lime flakes from the metal, a flaw is indicated as being present.

(iv)In another method an aluminum foil is laid over a wider strip of water soluble paper and both are stuck with a tape over the welded seam of a water filled pressure vessel. If a leak exists, the water soluble strip will dissolve, indicating the leak location and the aluminum foil strip will be in electrical contact with the vessel. A corresponding change in resistance indicates the pressure of leak.