

## **RISK ASSESSMENT**

Managing these accidental risks in today's environment is the concern of every industry including steel, because either real or perceived incidents can quickly jeopardize the financial viability of a business. Many facilities involve various manufacturing processes that have the potential for accidents which may be catastrophic to the plant, work force, environment, or public. Risk analysis involves the identification and assessment of risks; the neighboring populations are exposed to as a result of hazards present in the plant operation. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of populations etc. The risk analysis is often confined to maximum credible accident studies.

The main objectives of the Risk Assessment Studies are as given below:

- To identify the source of hazards in the unit.
- Assessment of risk on basis of different tools available.
- To safeguard employees and people in vicinity.
- To minimize damage to property and environment.
- To inform the employees, the general public and the authority about the hazards / risk assessed, safeguards provided, residual risk if any and the role to be played in them in the event of emergency.
- To inform authorities and mutual aid centers to come for help.
- To affect rescue and treatment of casualties.
- To secure the safe rehabilitation of affected areas and to restore normalcy.

### **1.1 RISK ASSESSMENT & AN APPROACH TO EMERGENCY PREPAREDNESS PLAN**

Risk assessment study includes study of nature of hazards due to the proposed expansion of the M.S. Ingots/Billets manufacturing unit including operations activities and machinery handling.

The study includes:

- Preliminary identification of hazardous area.
- Identification of cause of accident.
- Analysis of maximum accidental scenarios.
- Study of characteristics of risk levels.
- Evaluation of damage criteria.

Hazard identification provides information on hazardous substances, their nature, quantities and details of storage.

Preliminary hazard identification is used to identify typical and often relatively apparent risk sources and damage events in a system.

## 1.1.1 Identification of Hazards

### 1.1.1.1 Major Hazards

Hazard is the associated term with material, which is a measure or the likely hood of the damage to human working with, or studying the material in question.

All the probable potential hazardous is classified under different heads.

- **Fire Hazards:** Since the Stone Age term 'fire' is associated with fear. It is very dangerous if occurs in uncontrolled manner. When a liquid is used having flash point below the normal ambient temperature, it could, in suitable circumstances, liberate a sufficient quantity of vapour to give rise to flammable mixtures with air.
  - **Toxic Gas Release Hazards:** Toxic substances affect in three ways by ingestion, absorption & inhalation
  - **Explosion Hazards:** Release of energy in a rapid and uncontrolled manner gives rise to explosion
  - **Corrosion Hazards:** Corrosion is a chemical reaction-taking place at the surface of metal
- M/S Jagriti Steel Pvt Ltd is M.S. Ingot/Billet manufacturing unit. Thus, it possess fire hazards because it deal with molten metal of high temperature.

The lists of source of fire and explosive hazards are given below:

- Induction furnace with CCM
- Ladle furnace
- Rolling mill.

In all the above furnaces the temperature is too high and continuous cooling is required but if the cooling fails there are chances of explosion. The molten metal taken through ladle furnace to CCM and spillage during the travel can cause burn and fire. In rolling mill the molten metal travel through series of mills and there are chances of burn while handling the bars. Along with this the induction furnace is electric fired thus, higher amount of power load is required which may sometime causes risk of fire in electric wiring.

Following are the measures to prevent the hazards:

- Cooling of induction furnace should be continuous and back up cooling system should be installed in case one of the systems fails to cool.
- Overhead water tank should be placed for continuous water supply.
- D.G. set should be installed for power back up and prevent sudden shut of furnaces.
- The worker should be provided with gloves and shoes to prevent any burn incidences.
- The wiring in the industry should be fire insulated to prevent any fire incidences
- Organization of an investigative team to study the accident and to record the same to avoid repetition of such an accident in future.
- Provide training to specific company personnel in first aid as well as preliminary rescue operations.
- Arrangement for medical aid centers being informed immediately in case of such an event.

### ***1.1.1.2 Accidents***

#### **➤ Process Operations**

The process operation may lead to serious injuries at the site.

- Power failures.
- Failure of utility services.
- System failure
- Defective communication system

#### **➤ Types of Accidents**

- In steel industries accidents may occur due to the mishandling of the materials.
- In steel making process burns may occur due to the heat generation in furnace.
- Improper handling of mechanical transportations within the work areas.

### ***1.1.1.3 Risk Assessment***

Risk will be assessed by:

- To identify potential hazard areas.
- To identify the chances of explosion.
- Recommendations to minimize accidental possibilities.
- Preparation of Disaster Management Plan (DMP)
- Identifying the emergency plan.

### ***1.1.1.4 Risk Prevention Methods***

#### **➤ Safety And Health Measures (Safety Organization)**

- Safety organization is of prime importance in the steel industry, involving all persons in site hazard assessments, behavior observation and feedback exercises can promote positive safety attitude and focus work groups to prevent injuries and illnesses.
- Accident statistics identifies danger areas and require additional protection as well as greater stress on housekeeping. The value of different types of protective clothing will be evaluated and the advantages can be communicated to the workers concerned.

#### **➤ Training**

Training will include information about hazards, safe methods of work, avoidance of risks and the use of PPE. Training and refresher courses for all levels of personnel are particularly valuable. They will be familiarized personnel with safe working methods, unsafe acts to be prescribed, safety rules and the chief legal provisions associated with accident prevention. Training will be conducted by experts

and will make use of effective audio-visual aids. Safety meetings or contacts will be held regularly for all persons to reinforce safety training and awareness.

#### ➤ **Engineering and Administrative Measures**

- All dangerous parts of machinery and equipment, including lifts, conveyors, long travel shafts and gearing on overhead cranes, will be securely guarded. Preventive maintenance plan should be adopted.
- Proper housekeeping should be followed.

#### ➤ **Industrial Hygiene**

- Good ventilation system with proper air circulation and maintaining the cleanliness and housekeeping.
- To improve work environment, induced ventilation will be installed to supply cool air. Pedestal fans/ blowers are provided to give the comfort of working. Heat protection can be provided by installing heat shields between workers and radiant heat sources, such as furnaces or hot metal, by installing water screens or air curtains in front of furnaces or by installing heat-proof wire screens.
- Acclimatization to the work environment.
- Wherever possible, sources of noise will be isolated.

#### ➤ **Personal Protective Equipment**

All parts of the body are at risk in steel industries. Type of protective wear required will vary according to the activities & location. Those working at furnaces need clothing that protects against burns-overall of fire-resisting material, spats, boots, gloves, helmets with face shields/goggles. Safety glasses and helmets are imperative in almost all occupations and gloves are widely necessary.

#### ➤ **Medical Supervision**

- Medical examinations are of great importance in selecting persons suitable for the iron and steel making industries.
- Medical supervision required for those exposed to heat stress; periodic chest examinations will be provided for those exposed to dust, and audiometric examinations for those exposed to noise; mobile equipment operators will also receive periodic medical examinations to ensure their continued fitness for the job.

### **1.1.2 Disaster Management Plan Including Risk Assessment and Damage Control**

Rapid development has proposed wide-ranging hazards threatening safety and health of people. Accidents may adversely affect the environment and the people living in the vicinity. These accidents can be minimized to a great extent by proper procedures, handling and training.

### ***1.1.2.1 On-Site Emergency Plan***

The emergency is caused by an accident that takes place in a hazardous installation and the effects are confined to the factory premises involving the people working in the factory. On-site emergency plan is dealing with eventualities and it is the responsibility of the occupier, to prepare/ implement necessary measures to contain the severity of cause of disaster to the bare minimum. Furnishing of relevant information to the district administration authority for the preparation of the off-site emergency plan is statutory responsibilities of the occupier of every industry and other units.

### ***1.1.2.2 Objectives***

Maximize the resource utilization and combined efforts towards emergency operations. It broadly covers the following:

- Safety of the personal located in the premises.
- To minimize the effects of accidents on people, property and environment.
- To take remedial measures within time.
- To utilize the internal resources in the most effective way.
- To minimize the damage.
- To keep the required emergency equipment at designated places.
- To keep the concerned personnel fully trained for the use of emergency equipment.
- To mobilize effected persons.

### ***1.1.2.3 Basic Contents of Disaster Management Plan (DMP)***

An emergency is said to have arisen when operators in the plant are not able to cope up with a potential hazardous situation i.e. loss of control of an incident causes the plant to go beyond its normal operating conditions, thus creating danger. When such an emergency evolves, chain of events affect the normal working within the factory area and / or which may cause injuries, loss of life, substantial damage to property and environment both inside and outside the factory and a DISASTER is said to have occurred.

The various steps involved in the process of Disaster Management can be summarized as:

- Minimize Risk Occurrence (Prevention)
- Rapid Control (Emergency Response)
- Effectively Rehabilitate Damaged Areas (Restoration)

Basically, the Disaster Management Plan (DMP) contains the following aspects:

- Location of the site.
- Brief Description of Unit.
- Details of major potential hazards.
- Identification of specific type of disasters.

- Action plan – specific responsibilities.
- Declaration of emergency with emergency action plan.
- Evacuation and assembly points.
- Evaluation of implementation system.

## **Purpose & Scope**

The principal aim of DMP of steel unit is prevention of identified major hazards. It is totally committed to “Total Quality Assurance” from conception stage to enable its objective of prevention. The control strategy adopted could be reducing potential by way of minimizing the handling of such materials manually by individuals both in process and storage within the purview of continuous operation.

The adopted control measure could be well structured and well-rehearsed. On site plan which could intercept any such occurrence with speed and rectify by ensuring safety of worker, equipment, public and ultimately the environment as a matter of priority. General details like location, project layout, neighboring entities and the assistance they can render etc are as follows.

The important elements considered in this plan are:

- Statutory requirements.
- Roles and Responsibilities.
- Communications during emergency.
- Emergency shutdown & control of situation.
- Rescue & rehabilitation.
- Emergency facilities.
- Important information.

The primary purpose of the on-site emergency plan or DMP is to control and contain the incident and to prevent it from spreading. It is not possible to cover every eventuality in the plan and the successful handling of the emergency will depend on appropriate action and decisions being taken on spot.

### ***1.1.2.4 Preventive Measures & Plans***

DMP specifies the actions to be taken in case of such incident, including its prevention, corrective action so as to mitigate such occurrence by the proponent. Practice and procedure with respect to the operational hazards, equipment failure, human safety, malfunctioning of safety interlocks. Natural disasters relevant to unit and its different section of operation will be formulated and a detailed disaster management action plan will be prepared and made available to all concerned persons to take care of the following aspects.

- To install emergency alarm for immediate information.
- A suitable location inside the unit will be demarcated for assembly point.
- Intercom will be provided to all departments for easy and immediate means of communication.
- At sensitive fire prone areas fire alarm and fire hydrant lines will be provided.
- Workers will be trained regularly to use personal protective equipment.

- Mock drill will be conducted at regular interval to evaluate the effectiveness of the emergency preparedness plan.
- First aid boxes will be made available at various sensitive points to meet the requirement.
- Personnel will be appointed and responsibilities will be assigned.
- Color-coding will be followed as per the statutory requirements.
- All heavy moving machines will be properly maintained and protected and valid license will be obtained before their usage.
- All applicable Indian laws, rules and regulations for which company subscribes shall be strictly followed under a senior qualified environment and safety personal.

### **1.1.3 Emergency Management**

The emergency control center will be located in an area of minimum risk. Suitable location from where clear view of the unit is possible.

#### ***1.1.3.1 Infrastructure at Emergency Control Centre***

Emergency control center contains the following:

- An adequate number of external telephones.
- An adequate number of internal telephones.
- Areas where there are large inventories of hazardous materials.
- Sources of safety and first aid equipment.
- The fire-fighting system and additional sources of water.
- Site entrance and roadways, including up-to-date information on road traffic.
- Assembly points.
- Vehicle parking.
- Additional work and lay out plans detailing alternate routes and affected areas during an emergency.
- A list of key personnel, with addresses, telephone numbers, etc.

The emergency control center will be located in an area of minimum risk. Suitable location from where clear view of the unit is possible.

#### ***1.1.3.2 Health and Safety Measures For The Workers***

- **Belts etc:** The fitness of the belts should be regularly checked.
- **Helmets:** To avoid any head injury helmets to be provide.
- **Machinery:** All machines should be operated as per operation manual.
- **Methods of work:** Work instructions should be followed.
- **Electricity:** Electric installation should be carried during the idle hours of working.
- **Medical Check-up:** Regular medical Checkups shall be carried as per the annual plan.

#### ***1.1.3.3 Safety of Personnel***

Adequate personal safety equipment as applicable to the work i.e, industrial safety shoes, hand gloves, ear muffs, welder's screen, aprons, gas masks, respirators, safety belts, goggles, etc. are to be provided to the workers.

#### ***1.1.3.4 Emergency Action Plan for Fire***

The fire proximity suits be made available at the site to fight with the fire & Adequate personal safety equipment as possible to the work i.e. industrial safety shoes, hand gloves, ear muffs, welder's screen, aprons, gas masks, respirators, safety belts, goggles etc. are to be provided to the workers.

#### ***1.1.3.5 Emergency Action Plan For Electric Shock Casualties***

##### **➤ Rescue And First Aid**

- Provide first aid without delay.
- Switch off the supply immediately.
- Use of non-conducting material to separate the victim.
- The rescuer should use the gloves or using a jacket to pull the victim.

#### ***1.1.3.6 First Information***

The first person who observes/ identifies the emergencies will inform by shouting and by telephone to the Shift- in-charge and fire station about the hazard. The shift-in-charge will inform to the incident controller.

#### ***1.1.3.7 Declaration of Emergency***

The Chief Incident Controller taking into account of the severity of the situation will declare emergency.

- **Emergency Alarm:** Emergency will be declared by Emergency alarm, which will be sounded by fire station on receipt of orders from Shift in-charge/ Works Incident Controller.
- **Evacuation:** In an emergency it is necessary to evacuate personnel from affected areas and as precautionary measure to evacuate non-essential workers. In the first instance from areas likely to be affected will be evacuated immediately. The evacuation will follow at Assembly points.
- **Mock Drills:** It is imperative that the procedures laid in this plan are put to the test by conduction Mock Drills. The mock drills will be carried out by the step as stated below.
  - **First Step:** Test the effectiveness of communication system.
  - **Second Step:** Test the speed of mobilization of the unit emergency teams.
  - **Third Step:** Test the effectiveness of search, rescue and treatment of casualties.
  - **Fourth Step:** Test emergency isolation and shut down and remedial measures taken on the system.
  - **Fifth Step:** Conduct a full rehearsal of all the actions to be taken during an emergency.

The Disaster Management Plan will be periodically revised based on experience gained from mock drills. There are two types of mock drills recommended in Disaster Management Plan – Full Mock Drill (to be conducted at least once in 6 months) and Disaster Management Efficacy Drill (to be conducted at least once in 3 months.)

- **Full Mock Drill:** This will be conducted with Unit Head, Head of O & M as General Manager; Heads of Operation, Maintenance, Medical, Personnel, Security, Auto Base and Materials as Members and Head of Safety as Convener and it shall test the following:
  - Properly functioning of Emergency Control Centre.
  - To evaluate communication of the Disaster Plan to all segments of employees.
  - To ensure that all facilities as required under the plan are available.
  - To ensure that the necessities under material assistance scheme is properly documented and the concerned employees are fully aware in this regard.
  - To ensure that the employees are fully aware to fight any emergency.

#### ***1.1.3.8 Objectives of Onsite Emergency Plan***

A quick and effective response at that time can have tremendous significance on whether the situation is controlled with little loss or it turns into a major emergency. Therefore, the purpose of this Onsite Emergency Plan (OSEP) is to provide basic guidance to the personnel for effectively combating in case of an emergency.

To maximise the resource utilisation & combined efforts towards emergency operations as follows:

##### **➤ During an Emergency**

- To increase thinking accuracy and to reduce thinking time.
- To localize the emergency and if possible eliminate it.
- To minimize the effects of accident on people and property.
- To take correct remedial measures in the quickest time possible to contain the incident and control it with minimum damage.
- To prevent spreading of the emergency situation to other sections.
- To mobilize the internal resources and utilize them in the most effective way.
- To arrange rescue and treatment of casualties.

#### ***1.1.3.9 Elements of Onsite Emergency Plan***

The important elements considered in this plan are:

- Emergency Organization
- Emergency Procedures
- Emergency Facilities
- Roles and Responsibilities
- Emergency Communications
- Emergency Shutdown
- Emergency Action for Control of situation and Mitigation
- Important Information

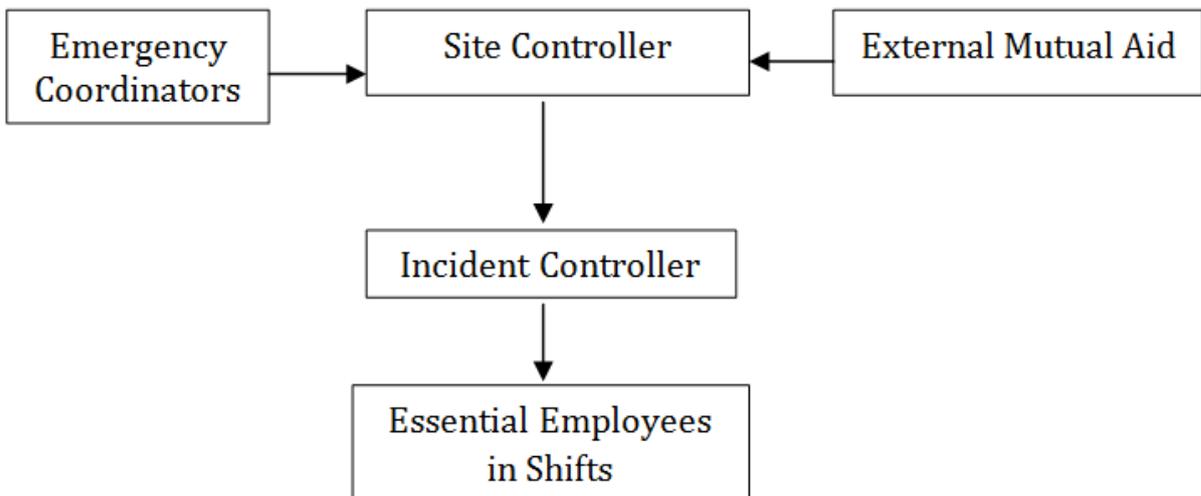
### 1.1.3.10 Methodology

The consideration in this emergency planning includes the following:

- Identification and assessment of hazards and risks
- Identifying, appointment of personnel & Assignment of Responsibilities
- Identification and equipping Emergency Control Centre
- Identifying Assembly, Rescue points, Medical Facilities
- Formulation of plan and of emergency sources
- Action on site Training, Mock Drill & Evaluation
- An emergency organization is constituted towards achieving objectives of this plan.
- General Manager is designated as site controller and over all in charge of onsite emergency management. Head- Production is designated as an alternate to general manager. Head- Laboratory is second alternate.
- Mechanical, Head - Laboratory, Security In-charge are designated as Emergency Coordinators.
- Shift In-charge of Production is designated as Incident Controller. This being a process industry, round the clock, Shift In-charge would be available.
- All the above are Key Persons in Onsite Emergency Management.
- All Engineers / Supervisors, Chemists in the shift, Assistants in the Shift, Operators in the shift, Technicians in the Shift, Trained First Aiders, Trained Fire Fighters, Security Guards, Drivers of the Transport Vehicles are designated as Essential Employees.



Figure Error! No text of specified style in document.-1: Elements of Onsite Emergency Plan



**Figure Error! No text of specified style in document.-2:Emergency Organisation in Shift**

➤ **Onsite Controller**

- In the absence of Site Controller, assumes the role of Site Controller in addition to his role as Incident Controller. On arrival of Site Controller, hands over the charge of Site Controller by word and continues to act at Incident Controller.
- Proceed to site quickly
- Assess the magnitude of the incident
- Arrange to inform the Occupier
- Protects him and initiates the emergency procedure to secure the safety of workers and minimize damage to installation and property.
- Direct, rescue and firefighting operations until (if necessary) the fire brigade arrives
- Ensure that adequate Personal Protective Equipment is available for Emergency Team
- Arrange for search of casualties
- Arrange evacuation of non-essential workers to assemble at designated assembly point.

➤ **Emergency Coordinator (Departmental Heads)**

- On hearing about an Emergency, reach ECC and assist Site Controller in all respects
- Seek information and instruction whenever necessary
- Ensure special equipment like compressed air, power supply
- During normal times, take stock of emergency needs including special equipment, blinds, sealing material, available.
- Seek information and instruction whenever necessary
- Organize emergency illumination including cutting of power supply to affected areas

➤ **Emergency Coordinators (Personnel Manager)**

- On hearing about an Emergency, reach ECC and assist Site Controller in all respects

- Seek information and instruction whenever necessary
- Send Information to Emergency Services like Fire / Ambulance
- Organize Emergency Transport for shifting injured / affected
- Organize Emergency and First Aid for injured / affected
- Organize head-count for rescue / evacuation / and organize rehabilitation and other humanitarian needs of those who are evacuated and send proper intimation to their kith and kin.
- Maintain sufficient stock of first aid material, stretchers and other emergency equipment for rescue.
- Organize liaison with neighboring industries regarding mutual aid
- Keep informed Statutory Authorities and Management, on the instructions of Site Controller.
- Direct Security In-charge regarding control at gate and for law and order coordinate with Police Authorities and appraise Site Controller on a continuous basis .
- Coordinate with other Emergency Coordinators for effective control of situation
- He is responsible for maintenance of Emergency Control Centre and Assembly Points

➤ **Emergency Coordinators (Security In-Charge)**

- On hearing about an Emergency, reach ECC and assist Site Controller in all respects
- Seek information and instruction whenever necessary
- Ensure availability of firefighting equipment in order
- Train regular and new Security Guards regarding plant hazards and demonstrate emergency actions and firefighting, rescue and evacuation.
- Organize control measures at gate to prevent unauthorized persons entering the plant during emergency and liaise with police officials in maintaining law and order.
- Direct unconnected truck drivers and vehicles etc. to move away from plant to a safe location
- Security guards posted in night are to be fully informed of emergency telephones and how to communicate emergencies if required.
- Arrange Emergency Telephone numbers displayed in security and are to be updated as and when there is a change.

**1.1.3.11 Risk Assessment Matrix**

➤ **Likelihood**

- Almost Certain
- Probable
- Possible
- Possible (under unfortunate circumstances)
- Rare

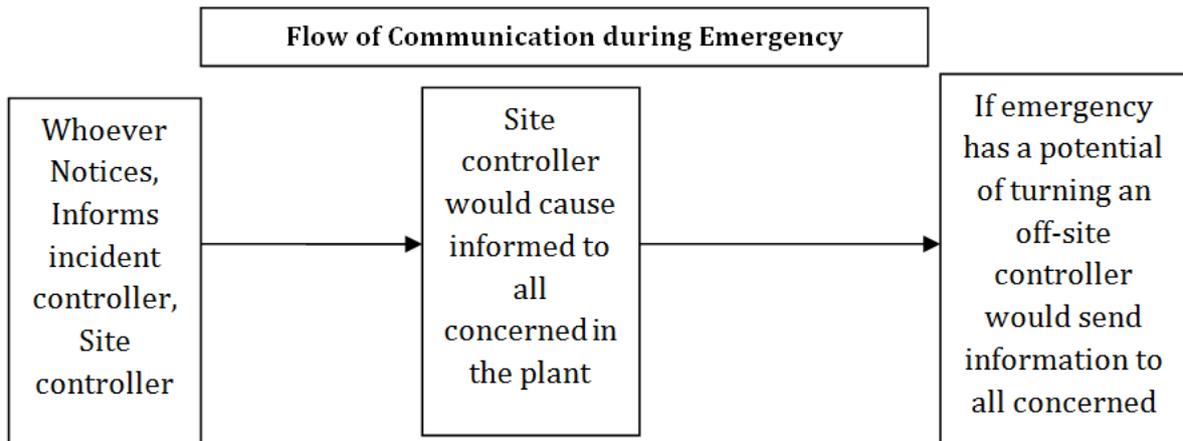
➤ **Severity**

- Fatality
- Major Injury, resulting in disability
- Injury Requires, Doctor's or Hospital attendance
- Minor Injury, 1st Aid required

- Minor Injury, 1st Aid not required

➤ Risk Rating

Is calculated by multiplying the likelihood against the consequences, e.g. taking a likelihood of 4, which is classified as Probable, and multiplying this against a consequence of 2, which is classified as a Minor Injury 1st aid required, would give you an overall risk rating of 8, which would be risk rated as a low risk.



**Figure Error! No text of specified style in document.-3: Communication process**

**Table Error! No text of specified style in document.-1: Risk Assessment**

<b>High risk equals 16 to 25</b>	High Risks activities should cease immediately until further control measures to mitigate the risk are introduced.
<b>Medium risk equals 9 to 15</b>	Medium Risks should only be tolerated for the short-term and then only whilst further control measures to mitigate the risk are being planned and introduced, within a defined time period. Note: Medium risks can be an organizations greatest risk, it's achilles heel, this due to the fact that they can be tolerated in the short-term.
<b>Low risk equals 1 to 8</b>	Low Risks are largely acceptable, subject to reviews periodically, or after significant change etc.

**Table Error! No text of specified style in document.-2: Risk AssessmentGeneral Risk Assessment**

S. NO.	Hazards & details	Persons at risk	Control measures	Action plan in case of emergency	Risk		
					Likelihood	Severity	Risk rating
					L	S	Rr= l x s
1	Induction furnace-fire	Persons working in the	Emergency alarm to be put on to signal the emergency.	Switch off the system.	2	3	6

**Table Error! No text of specified style in document.-2: Risk AssessmentGeneral Risk Assessment**

S. NO.	Hazards & details	Persons at risk	Control measures	Action plan in case of emergency	Risk		
					Likelihood	Severity	Risk rating
					L	S	Rr= l x s
	hazard caused by fuels/ignitable substances.	Furnace area- Burns may be possible if directly coming in contact.	<p>Firefighting equipment power/foam type extinguishers on vehicles and mounted on walls are kept readily available</p> <p>Water hose is provided.</p> <p>No smoking zone declared.</p> <p>Plant workers are trained to fight fire.</p>	<p>Water hose will be operated to set out the fire depending on the situation.</p> <p>Outside fire brigade is to be called if the fire cannot be extinguished immediately.</p> <p>Inform the occupier/manager and activate the onsite emergency plan.</p> <p>Immediate first aid to the victim and sent to hospital for treatment.</p>			
2	In case of furnace crack, molten metal may leak causing splash of hot metal.	Persons working in the tapping area.	<p>Continuous monitoring of furnace shell is done to maintain and observe proper temperature.</p> <p>Movement of staff and labor is not permitted near the furnace.</p> <p>Heat zone sign is displayed near the furnace.</p> <p>Safety shoes, safety goggles, hand gloves, apron and safety helmet provided to workers.</p> <p>Plant workers are trained to fight fire</p>	<p>Immediately drain out the furnace by pouring or tapping out. Molten splashed metal is allowed to cool down before removing.</p> <p>Further process is stopped till repairs are conducted.</p> <p>In case of fire, firefighting equipment are used to set out the fire.</p>	2	4	8

**Table Error! No text of specified style in document.-2: Risk AssessmentGeneral Risk Assessment**

S. NO.	Hazards & details	Persons at risk	Control measures	Action plan in case of emergency	Risk		
					Likelihood	Severity	Risk rating
					L	S	Rr= l x s
3	Slag pot leakage due to breakage.	Persons working in the tapping area.	Frequent checking of slag pot to be observed.	Further process should be stopped till slag cools down and after cooling the slag is removed carefully.	3	4	12
4	Molten hot metal may fall on human body.	Persons working in the tapping area.	Whole process is done under supervision of qualified/ trained persons	No entry zone should be declared.	3	4	12
			Only trained labors are allowed with proper heat proof dress/gum, boots/ aprons	First aid should be given to the victim and send to hospital for further treatment.			
			Entry of other workers /persons is strictly prohibited.				
5	Hoist rope breakage in E.O.T. crane	Persons standing below the crane bay and in nearby areas.	No movement of strange people in crane bay is permitted.	Crane movement is carried out only after getting the signal of line clearance.	1	5	5
			Frequent checking of rope and other load bearing material before process is started.				
			Cranes are not allowed to operate without line clear signal.				
			Weak rope is immediately replaced.				
6	Electrical Transformer-	Persons near the transform	Shock proof insulated PCC Platform.	Cut off power supply.	2	3	6
				Treat the injured for electrical shock.			

**Table Error! No text of specified style in document.-2: Risk AssessmentGeneral Risk Assessment**

S. NO.	Hazards & details	Persons at risk	Control measures	Action plan in case of emergency	Risk		
					Likelihood	Severity	Risk rating
					L	S	Rr= L x S
	Electrical shock and fire	er		If fire is caused, immediately fight fire with available resources, summoning outside help if necessary.			
7	Lab-Chemicals -in case of bottle breakage, causes burns and damage to respiratory systems due to inhalation	Persons working in the lab.	<p>Proper care should be taken while handling the chemicals.</p> <p>First aid box should be available at the site with all necessary and required medicines.</p> <p>Firefighting equipment like fire extinguishers, sand buckets should be always available.</p> <p>Instruction boards to be displayed for knowledge of other workers to care of the situation in the event of occurrence.</p>	<p>Immediately treat the persons as guided in the MSDS.</p> <p>Hospitalize the effected person if deemed necessary.</p>	3	2	6
8	Cooling Tower-Burns from returning hot water	Persons working with the cooling tower.	<p>All workers are not permitted near the tank and hot water line. Railing is provided all around the tank.</p> <p>Always precautionary measures should be taken and adopted.</p>	<p>Victims are first aided by trained person and then referred to Doctor/Hospital.</p> <p>If any worker gets hurt, then immediate first aid should be provided to him and he should be referred to the Hospital/doctor for further treatment.</p>	2	3	6

**Table Error! No text of specified style in document.-2: Risk AssessmentGeneral Risk Assessment**

S. NO.	Hazards & details	Persons at risk	Control measures	Action plan in case of emergency	Risk		
					Likelihood	Severity	Risk rating
					L	S	Rr= l x s
9	Charging of scrap and other material in furnace and moving parts like fly wheel, roller stand and other accessories-cut/burn and fire may be possible.	Persons working in the raw material handling yard and in the furnace floor.	<p>Workers are provided with gloves &amp; proper equipment to handle and feed the scrap.</p> <p>Workers charging the materials in the furnace are equipped with fire proof dress and proper equipment to handle the scrap and material.</p> <p>Fireproof system made available and firefighting equipment like extinguisher &amp; water with sufficient number of points easily available.</p> <p>Only trained &amp; qualified people will operate the furnace.</p>	Immediate first aid should be given to the victim by trained person and refer to the doctor/hospital for further treatment.	3	3	9
10	Furnace transformer-Fire Hazard	Persons working in Furnace area and in the electrical sections.	<p>Furnace will be operated with prescribed load.</p> <p>Carefully changing of tap on load.</p> <p>Temperature of furnace/ transformer should be observed continuously.</p> <p>Furnace oil level/quality should be mentioned.</p> <p>Unauthorized persons will be restricted and no-</p>	<p>Power line should be immediately put off.</p> <p>Firefighting steps should be taken to stop fire.</p> <p>Further processing must be stopped till repairing is over.</p>	2	3	6

Table Error! No text of specified style in document.-2: Risk AssessmentGeneral Risk Assessment							
S. NO.	Hazards & details	Persons at risk	Control measures	Action plan in case of emergency	Risk		
					Likelihood	Severity	Risk rating
					L	S	Rr= l x s
			Entry Board will be put up.				
11	Water tank-drawing of personnel	Persons near the water tank	Water tank will be fenced/ covered. The tank will not be permitted for general utility.	Drowned person should immediately be given first aid.	2	2	4
12	Control Room electrical shock	Persons working in the control room	Earth leakage circuit breaker installed.	Main supply will be immediately shut off.	2	2	4
Responsibility;							
Site Controller; head-production							
Incident controller: Shift-in charge							
Emergency Co-coordinators: Departmental Heads.							

### 1.1.4 Heat Stress

Aim is to maintain body core temperature within +1°C of normal (37°C). This core body temperature range can be exceeded under certain circumstances with selected populations, environmental and physiologic monitoring, and other controls.

#### 1.1.4.1 Source

High temperature and humidity; direct sun or heat; limited air movement; physical exertion; poor physical condition; some medicines; inadequate tolerance for hot workplaces; and insufficient water intake can all lead to heat stress

Table Error! No text of specified style in document.-3: Heat Stress				
Signs & symptoms	Cause	Symptoms	Treatment	Prevention
<b>Heat Rash</b>	Hot humid environment; plugged sweat glands.	Red bumpy rash with severe itching.	Change into dry clothes and avoid hot environments. Rinse skin with cool water.	Wash regularly to keep skin clean and dry.
<b>Sunburn</b>	Too much exposure to Sun.	Red, painful, or blistering and peeling skin.	If the skin blisters, seek medical aid. Use skin lotions and work in the shade.	Work in shade; cover skin with clothing; use sun protection lotions with the factor 15.

<b>Table Error! No text of specified style in document.-3: Heat Stress</b>				
<b>Signs &amp; symptoms</b>	<b>Cause</b>	<b>Symptoms</b>	<b>Treatment</b>	<b>Prevention</b>
<b>Heat Cramps</b>	Heavy sweating	Painful cramps in arms, legs or stomach which occur suddenly at work or later at home.	Move to a cool area and drink cool salted water.	While working in the heat, workers should put salt on their food and avoid taking salt tablets.
<b>Fainting</b>	Not enough blood flowing to the head, causing loss of consciousness.	Sudden fainting after two hours of work; cool moist skin; weak pulse.	Fainting may be due to the heart attack get the medical aid immediately and move to the cool place; loosen clothing and make the person lay down. Offer sips of cool water.	Reduce activity levels and/or heat exposure. Drink fluids regularly. Drink fluids regularly.
<b>Heat exhaustion</b>	Inadequate salt and water intake causes a person's body's cooling system to start to break down.	Heavy sweating; moist skin; body temperature over 38 deg. Centigrade; weak pulse; normal or low blood pressure; person is tired, weak clumsy, upset or confused; is very thirsty.	Arrange medical aid	Reduce activity levels and/or heat exposure. Regularly. Drink fluids regularly.
<b>Heat Stroke</b>	The body used all its water and salt, it will stop sweating and will cause body temperature to rise.	High body temperature(over 41 deg. Centigrade)	Call Ambulance. Meanwhile remove the excess clothing; start fan and spray with cool water; offer sips of cool water if the person is conscious.	Reduce activity levels and/or heat exposure. Regularly. Drink fluids.

<b>Table Error! No text of specified style in document.-4: Permissible Heat Exposure Threshold Limit Value</b>				
<b>WORK</b>	<b>LIGHT</b>	<b>MODERATE</b>	<b>HEAVY</b>	
Continuous work	30.0°C (86°F)	26.7°C (80°F)	25.0°C (77°F)	
75 % work, 25% rest, each hour	30.6°C (87°F)	28.0°C (82°F)	25.9°C (78°F)	
50 % work,50% rest, each hour	31.4°C (89°F)	29.4°C (85°F)	27.9°C (82°F)	
25 % work,75% rest, each hour	32.2°C (90°F)	31.1°C (88°F)	30.0°C (86°F)	

### 1.1.5 Occupational Health & Safety

In general occupational health and safety is an interdisciplinary area concerned with safety, health and welfare of people engaged in industries.

The main concerns of occupational health are:

- Promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations
- Prevention amongst workers of departures from health caused by their working conditions
- Protection of workers in their employment from risks resulting from factors adverse to health.
- Placing of worker in an occupational environment suitable to his physiological and psychological capabilities.

Working conditions and the nature of employment tend to have major repercussions on the health of a workman. The concept of 'Occupational health' has evolved from work-related ailments. Occupational health broadly means any injury, impairment or disease affecting a worker or employee during his course of employment. Further, it not only deals with work-related disorders but also encompasses all factors that affect community health within it.

The occupational health and safety laws exist in all countries including India which makes the employee of the worker responsible for any damages to its work force. The ignorance of law cannot be an excuse under any circumstances. Hence, the owners and managers must have the basic knowledge of the subject.

#### ***1.1.5.1 Legal Provisions***

The Indian Constitution has shown notable concern to workmen in factories and industries as envisaged in its preamble as Directive Principles of State Policy.

- For securing the health and strength of workers, men and women
- That the tender age of children is not abused
- That citizens are not forced by economic necessity to enter avocations unsuited to their age or strength
- Just and humane conditions of work and maternity relief are provided and,
- That the Government shall take steps, by suitable legislation or in any other way, to secure the participation of workers in the management of undertakings, establishments or other organizations engaged in any industry

The Factories Act, 1948, the Mines Act, 1952, the Dock Workers (Safety, Health & Welfare) Act, 1986 are some of the laws, which contain provisions regulating the health of workers in an establishment. Whereas the Employees State Insurance Act, 1948 and the Workmen's Compensation Act, 1923 are compensatory in nature. It may be sufficient to indicate at this stage that metallurgical industries are classified as hazardous industry and legal provisions must be adhered to avoid any harm to work force and local residents in the vicinity of the industry.

#### ***1.1.5.2 Role of Management***

It is believed that “the safety begins at the top”. The ‘Safety Engineer’, ‘Foreman’ and “Supervisor’ can never achieve good result if the top management does not take lead in the promoting and maintaining a high standard of safety and health at work place. The cost towards ‘Health & Safety’ must be part of total production cost and should not be treated as extra.

The management concerned with safety has duties as below:

- Have undeniable decision making authority
- Lead in the establishment of rules and policies designed to promote safety and health, accident prevention and hazard awareness
- Be responsible for maintaining the safety policy, safety manual, the proper safety and health training documentation and the necessary recordkeeping
- Make all employees aware of the established safety and health rules of the safety policy
- Hold each employee responsible and accountable
- Monitor all aspects of the safety policy and safety manual
- Promote and ensure proper safety training, worksite audits, accident investigations, and hazard control
- Manage the safety team (committee)
- Conduct or coordinate all site safety inspections
- Manage safety violation and award program
- Provide and/or coordinate safety training for all new employees
- Be notified immediately regarding accidents and/or injuries
- Eliminate all hazardous practices performed by employees
- Assign and train a replacement in the event he/she is unavailable for duty

In any industry, particularly hazardous industry like metallurgical plants, the incidences do happen with many safety provisions. This needs investigation and modifications in the safety system. This requires accident statistics.

### **1.1.6 Accident Record**

India has had legislation on occupational safety and health for past 50 years. However, the nation lacks strong system to monitor and regulate incidences though it employs around 26 million industrial workers besides millions who work in the informal sector with absolutely no safeguards. The work safety improvements are possible when the related data is available for analysis.

#### **➤ Accident**

The occupational (industrial) accident can be defined as an undesirable event that results in a certain length of disability and stoppages of work and time loss due to the effect of production related dangerous factor. The accident may cause personal injury, material damage and loss of production time.

#### **➤ Injury**

The injury is an external damage to the human body resulting from accident. It can be mechanical (bruise, cut, tissue rupture, breakage etc.), chemical (burn, acute intoxication and poisoning), radiated

(tissue regeneration, changes in the hematopoietic system) or combined effect of more than one cause. The result of accident may be (serious, minor or no injury) may cause temporary or permanent disablement.

### ➤ Occupational Disease

The unhealthy condition caused to the person by exposure to unsafe working conditions

- **Occupational Poisoning:** It is occupational disease caused by long exposure of relatively small amount of poisonous material.
- **Accidental Poisoning:** Acute intoxication is caused by penetration of large amount of noxious substance in a short exposure.
- **Accident Investigation Form:** It is the principle document that provides information for record and statistical analysis of the data. This form gives the detail of the accident, injuries by cause and identification of cause. This may help in making policy to avoid its re- occurrence. This form must be filled within 24 hours

### ➤ Accidental Statistics

The statistical method is based on total number of accidents (serious and minor) compiled for a certain period of time. The statistical method is helpful in showing the distribution of accidents by occupation, length of service, age or sex, cause or type, nature of injury, equipment involved, and by organizational and technical factors.

The various indices used to indicate safety performance are following:

- **Number & Type:** The total number of incidences and its type record may help in planning the mitigation of incidents by adopting appropriate means.
- **The Frequency Coefficient (F):** It is defined as number of incidents per 1000 man hour exposure. It is expressed as;

$$F = (1000 T) / P,$$

Where, T - number of injuries for a given period  
P - Total man hours of exposure.

- **The Severity Coefficient (S):** It is defined as the average time loss (length of disability) due to incident per one incident for a given period. This is expressed as

$$S = D / T,$$

Where, D - Time loss in days due to all incidents that occurred for a given period  
T - Number of incidents in a given period.

- **Accident Responsibility:** In the event of an incident causing loss of production time, damage to equipment, injury to worker (minor, major, fatal) or loss of life the records form the basis of fixing the responsibility of the incidence. This could lead to different types of liability depending upon the nature of incident.

- **Disciplinary Liability:** This implies the punishment in the form of disciplinary action by the management which could be in the form of warning, reprimand, transfer, term demotion or dismissal.
- **Administrative Liability:** This implies penalties imposed by state authority for violating the safety regulations causing the incident.
- **Financial Liability:** This is compensation by the violator for losses and rehabilitation of the victim decided by court of law.
- **Criminal Liability:** This is a sanction by law for violating safety laws and industrial regulations causing accident and other serious consequences.

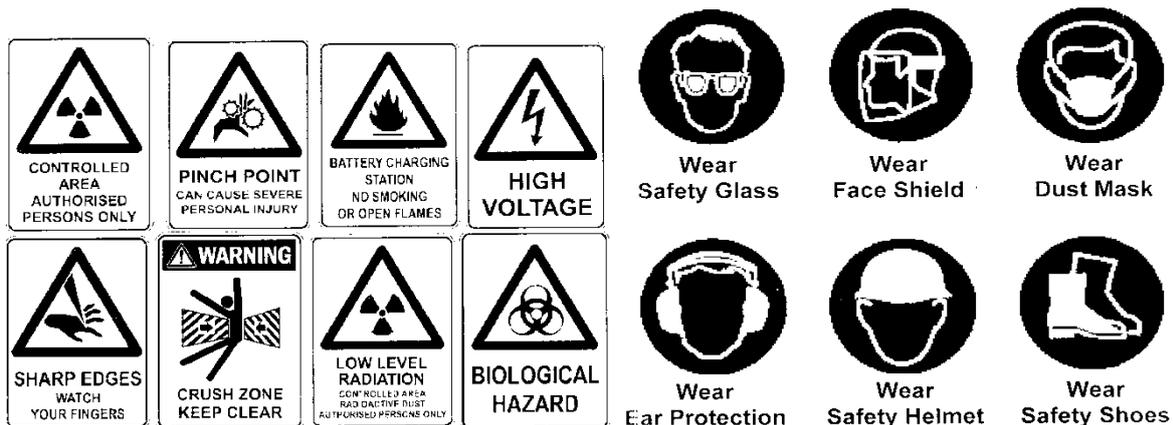
### 1.1.7 General Safety at Work

The safety at work begins at the planning stage. While planning various manufacturing units to provide safety measures like guards, emergency switches, interlocking and signaling (operating, warning, and indicating). In addition the training, good housekeeping, color labeling, display signs, notices etc. can help in improving safety at work and reduce the chance of accidents.

### 1.1.8 Safe Guards, Signals, Signs

The working areas must have safe guards at all moving and hazardous points to prevent casual access. The moving cranes and equipment must have sound and light signals to keep people at safe distance. The various activities in the area must be indicated by sign boards in suitably big size to warn people. This must be in local language of the area with mostly known language like English. Some typical sign are illustrated in figures 8.3.

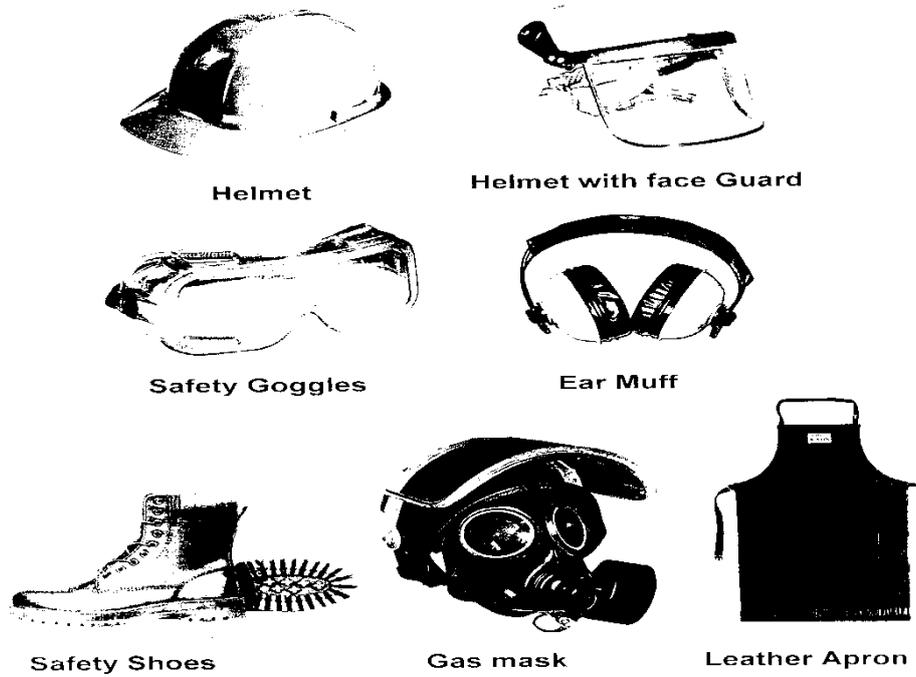
In addition to possible hazards the workers and visitors may be advised to use protection wears while working or entering in the area. The signs displaying such warnings are illustrated in figure 8.4



**Figure Error! No text of specified style in document.-4:Some Typical Warning Signs Figure Error! No text of specified style in document.-5:Signs for Putting Protection Wears in Various Areas of ThePlant**

### 1.1.8.1 Safety Guards

The use of safety helmet and shoes are mandatory in the plant area while the use of glasses, face shield, dust mask, ear muff are advisable in many parts of the plant depending on the hazard nature. Some of the safety gears are shown in figure 7.5.



**Figure Error! No text of specified style in document.-6: Commonly Used Safety Gears**

### 1.1.8.2 Electric Safety

Several accidents occur due to defective electrical systems. The machine frame, casings, motor guards, control panel etc. get connected to main electrical supply due to poor insulation, heat, moisture etc. Such incidents could be avoided by using good quality electrical fittings, providing electrical earth to the equipment, rubber / wooded matting at control panel.

### 1.1.8.3 Hoisting, Loading & Handling

The material is handled using cranes of different types. The ropes and chains are essential parts of the system. The strength of ropes and wires require high safety factor (k) which is expressed as

$$k = P / S$$

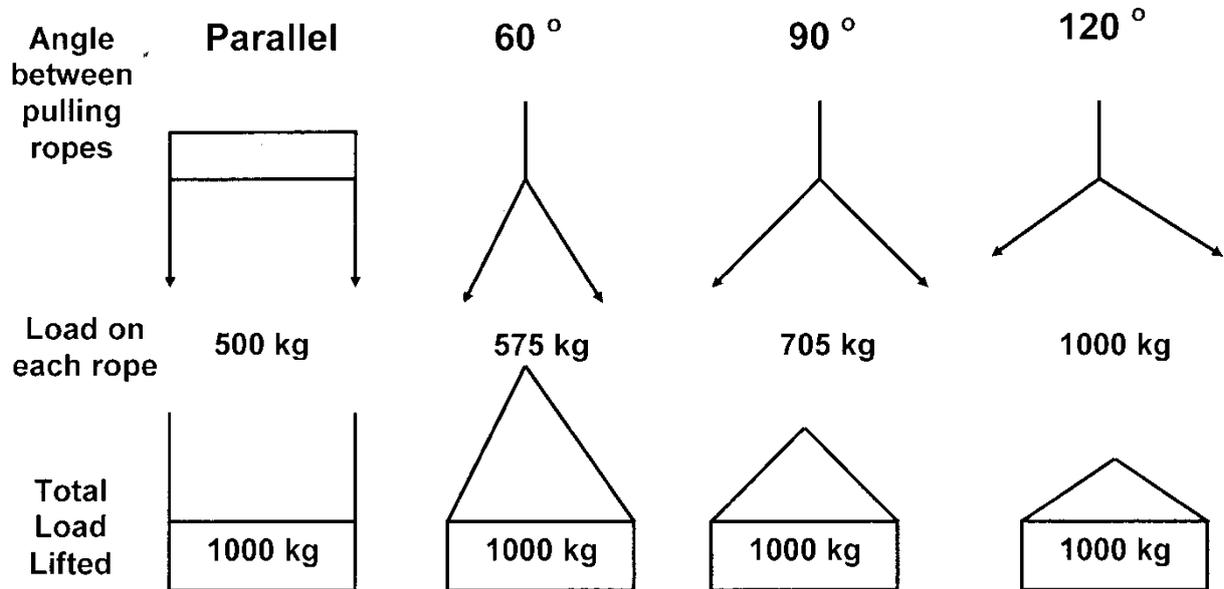
Where, P – Breaking load, N

S – Maximum anticipated stress, N

The safety factor (k) is generally kept 5-6 in most cases. It is kept as 9 when people are to be hoisted.

The stress in the rope depends on number of strand and the angle formed by pulling rope as shown in figure 7.6. The rope type and its quality selection must be made accordingly. The rope gets worn with time and use. These ropes must be inspected time to time before use.

The hook of the crane is a very critical component and must be tested periodically for any stress defect.



**Figure Error! No text of specified style in document.-7:Changes in Rope Stress Due to Pulling Rope Angle Caused by Sling Position**

#### 1.1.8.4 Safety Training & Drills

Safety training plays significant role in minimizing incident rate and fatality. A trained worker not only is able to help himself but he can also save others under given situation. This safety training is normally imparted to freshly employed persons but it is necessary to conduct refresher courses for trained persons also. The periodic mock drill is necessary to check the fitness and alertness.

#### 1.1.9 Occupational Health Monitoring & Record

The working conditions and the nature of employment are known to have major repercussions on the health of a workman. The concept of 'Occupational Health' has evolved from work-related ailments. Occupational health broadly means any injury, impairment or disease affecting a worker or employee during his course of employment. Further, it not only deals with work-related disorders but also encompasses all factors that affect community health within it.

Article 21 of the Indian Constitution guarantees the protection of life and personal liberty of a person. Various Supreme Court judgments have, under this "right to life" upheld the 'right to employees' health.

In view of this provision the employer is obliged to provide health care to its worker during employment and retirement period.

### **1.1.9.1 Health Examination**

The workers must be medically examined at the time of employment to observe the physical fitness and to know any ailment which may need care while placing him in some hazardous area. The medical examination must be done for every worker on annual basis to monitor the effect of working atmosphere on his health.

### **1.1.9.2 Health Record And Analysis**

The industry is supposed to keep health records of all its employees starting from employment date till their retirement.

These medical records must be analyzed annually to know the trend of employee health. In case some serious trend is noted then suitable action should be taken to address such health issues. Some typical health record analysis are given here as illustration.

- **Chest X-Ray:** The chest X-Ray is conducted to reveal the health problems associated with dust. Silicosis (particularly the acute form) is characterized by shortness of breath, cough, fever, and cyanosis (bluish skin). It may often be misdiagnosed as pulmonary edema (fluid in the lungs), pneumonia, or tuberculosis.
- **Spirometry Test:** Pulmonary function tests are a group of tests that measure how well the lungs take in and release air and how well they move gases such as oxygen from the atmosphere into the body's circulation. Spirometry (meaning the measuring of breath) is the most common of the Pulmonary Function Tests (PFTs), measuring lung function, specifically the measurement of the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled. Spirometry is an important tool used for generating pneumotachographs which are helpful in assessing conditions such as asthma, pulmonary fibrosis, cystic fibrosis, and Chronic obstructive pulmonary disease (COPD).

Pulmonary function tests are done to:

- Diagnose certain types of lung disease (especially asthma, bronchitis, and emphysema)
  - Find the cause of shortness of breath
  - Measure whether exposure to contaminants at work affects lung function
- **Electrocardiogram (ECG) Test:** The electrocardiogram (ECG) is a diagnostic tool that measures and records the electrical activity of the heart in exquisite detail. A typical ECG record is illustrated in figure 7.10 Interpretation of these details allows diagnosis of a wide range of heart conditions. These conditions can vary from minor to life threatening.
  - **Audiometry Test:** Audiometry is the testing of hearing ability, involving thresh-holds and differing frequencies. Typically, audiometric tests determine a subject's hearing levels with the help of an audiometer, but may also measure ability to discriminate between different sound intensities, recognize pitch, or distinguished speech from background noise. Acoustic reflex and optoacoustic emissions may also be measured. Results of audiometric tests are used to diagnose hearing loss or diseases of the ear, and often make use of an Audiogram.

- **Noise-induced hearing loss (NIHL)** is an increasingly prevalent disorder that results from exposure to high-intensity sound, especially over a long period of time. The ear can be exposed to short periods in excess of 120 dB without permanent harm — albeit with discomfort and possibly pain, but long term exposure to sound levels over 80 dB can cause permanent hearing loss.

There are two basic types of NIHL:

- **NIHL Caused by Acoustic Trauma:** refers to permanent cochlear damage from a one-time exposure to excessive sound pressure. This form of NIHL commonly results from exposure to high-intensity sounds such as explosions, gunfire, a large drum hit loudly and firecrackers.
  - **Gradually Developing NIHL:** refers to permanent cochlear damage from repeated exposure to loud sounds over a period of time. Unlike NIHL from acoustic trauma, this form of NIHL does not occur from a single exposure to a high-intensity sound pressure level.
- **Vision Test:** An eye examination is a battery of tests performed by an ophthalmologist and optometrist assessing vision and ability to focus on and discern objects, as well as other tests and examinations pertaining to the eyes. Health care professionals often recommend that all people should have periodic and thorough eye examinations as part of routine primary care, especially since many eye diseases are asymptomatic.

Eye examinations may detect potentially treatable blinding eye diseases, ocular manifestations of systemic disease, or signs of tumors or other anomalies of the brain.

- **A refractive error (RE):** or refraction error is an error in the focusing of light by the eye and a frequent reason for reduced visual acuity.

**Colour blindness:** or colour vision deficiency is the inability or decreased ability to see colour, or perceive color differences, under lighting conditions when color vision is not normally impaired. "Color blind" is a term which indicate a fault in the development of either or both sets of retinal cones that perceive color in light and transmit that information to the optic nerve.