Conveyor Operation and Maintenance

Participant handbook

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1. Introduction

Unit 1.1 - Understanding of Iron & steel industry

Unit 1.2 - Understanding various types of Iron & Steel Industry

Unit 1.3 - Creation of products in Iron & Steel industry

Key Learning Outcomes

At the end of this module, you will be able to:

1. Discuss about iron & steel industry
2. Discuss about development activities in iron & steel industry
3. Discuss about employment opportunities in India
4. Know about industry structure
5. Know about iron & steel plants in India
6. Know about steel making procedure
7. Know about processes involve in steel making

UNIT 1.1: Understanding of Iron & Steel Industry

Unit Objectives

At the end of this unit, you will be able to:

1. Understanding of industry
2. Understanding of development activities in the industry
3. Understanding of opportunities in India

1.1.1 Introduction

India is the world's third-largest producer of crude steel (up from eighth in 2003) and is expected to become the second-largest producer by 2016. The growth in the Indian steel sector has been driven by domestic availability of raw materials such as iron ore and cost-effective labour. Consequently, the steel sector has been a major contributor to India's manufacturing output.

India's crude steel capacity reached 109.85 Million tonnes (MT) in 2014-15, a growth of 7.4 per cent. Production of crude steel grew by 8.9 per cent to 88. 98 MT. Total finished steel production for sale increased by 5.1 per cent to 92.16 MT. Consumption of total finished steel increased 3.9 per cent to 76.99 MT.

India produced 7.34 MT of steel in the month of September 2015, which was nearly equal to the country's steel production in September 2014. The steel sector in India contributes nearly two per cent of the country's gross domestic product (GDP) and employs over 600,000 people.

1.1.2 Conditions for the growth of Iron and Steel Industries

The optimum conditions for the growth of Iron and Steel Industries are mentioned below:

1. Coal and iron-ore are required in large amounts in the production of iron and steel. The industry is, therefore, located either near coal producing areas or iron-ore producing areas.
2. Large amount of water is required to cool the smelt iron, which is heated to very high temperatures with the help of coal. The factories are generally located near rivers or lakes and near coal or iron-ore mines.

Other factors affecting the location of the steel plants are:

- availability of cheap labor near the steel plant,
- good communication, market, ports, etc.

Huge amount of capital is required for setting up of iron and steel plant. Though India is rich in coal, iron-ore and cheap labor, but large amount of capital makes it difficult to set up many steel plants.

1.1.3 Development activities in Iron & steel industry

Investments

Steel industry and its associated mining and metallurgy sectors have seen a number of major investments and developments in the recent past.

According to the data released by Department of Industrial Policy and Promotion (DIPP), the Indian metallurgical industries attracted Foreign Direct Investments (FDI) to the tune of US$ 8.7 billion, respectively, in the period April 2000–September 2015.

Some of the major investments in the Indian steel industry are as follows:

- National Mineral Development Corporation (NMDC) has planned to invest Rs 40,000 crore (US$ 6.1 billion) in the next eight years to achieve mining capacity of 75 million tonnes per annum (MTPA) by FY2018-19 and 100 MTPA by FY2021-22, compared to 48 MTPA current capacity.
- Posco Korea, the multinational Korean steel company, has signed an agreement with Shree Uttam Steel and Power (part of Uttam Galva Group) to set up a steel plant at Satarda in Maharashtra.
- Iron ore output in India is expected to increase by 25 per cent to 153 Million Tonnes in FY 2016, which in turn will help reduce iron ore imports by two-thirds to five Million Tonnes, SAIL plans to invest US$23.8 billion to increase the steel production to 50 MTPA by 2025.
- ArcelorMittal, world's leading steel maker, has agreed a joint venture with Steel Authority of India Ltd (SAIL) to set up an automotive steel manufacturing facility in India.
- Iran has evinced interest in strengthening ties with India in the steel and mines sector, said ambassador of the Islamic Republic of Iran, Mr Gholamreza Ansari in his conversation with Minister of Steel and Mines, Mr Narendra Singh Tomar.
- Public sector mining giant NMDC Ltd will set up a greenfield 3-million tonne per annum steel mill in Karnataka jointly with the state government at an estimated investment of Rs 18,000 crore (US$ 2.8 billion).
- JSW Steel has announced to add capacity to make its plant in Karnataka the largest at 20 MT by 2022.

Government Initiatives

The Government of India is aiming to scale up steel production in the country to 300 MT by 2025 from 81 MT in 2013-14.

The Ministry of Steel has announced to invest in modernisation and expansion of steel plants of Steel Authority of India Limited (SAIL) and Rashtriya Ispat Nigam Limited (RINL) in various states to enhance the crude steel production capacity in the current phase from 12.8 MTPA to 21.4 MTPA and from 3.0 MTPA to 6.3 MTPA respectively.

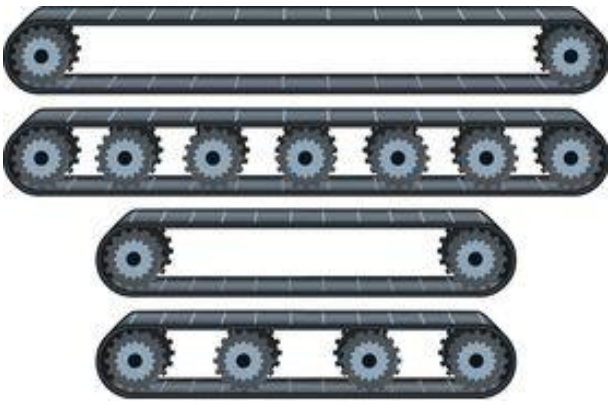
The Minister of Steel & Mines, Mr Narendra Singh Tomar, has reiterated commitment of Central Government to support the steel industry to reach a production target of 300 Million Tonne Per Annum (MTPA) in 2025.

The Ministry of Steel is facilitating setting up of an industry driven Steel Research and Technology Mission of India (SRTMI) in association with the public and private sector steel companies to spearhead research and development activities in the iron and steel industry at an initial corpus of Rs 200 crore (US$ 31.67 million).

Some of the other recent government initiatives in this sector are as follows:

- Government of India plans to auction eight coal blocks with reserves of 1,143 million tonnes to steel and cement firms in January 2016, as per coal secretary Mr Anil Swarup.
- Government has planned Special Purpose Vehicles (SPVs) with four iron ore rich states i.e., Karnataka, Jharkhand, Orissa, and Chhattisgarh to set up plants having capacity between 3 to 6 MTPA.
- SAIL plans to invest US$ 23.8 billion for increasing its production to 50 MTPA by 2025. SAIL is currently expanding its capacity from 13 MTPA to 23 MTPA, at an investment of US$ 9.6 billion.
- A Project Monitoring Group (PMG) has been constituted under the Cabinet Secretariat to fast track various clearances/resolution of issues related to investments of Rs 1,000 crore (US$ 152 million) or more.
- To increase domestic value addition and improve iron ore availability for domestic steel industry, duty on export of iron ore has been increased to 30 per cent.

1.1.4 Employment opportunities in Iron & steel industry



The total employment in the industry is more than two million (including direct and indirect employment). Most of the Steel plants are situated in economically backward regions of the country. Therefore, Steel companies have contributed to the overall development of civic, medical, educational and other facilities in these regions. Since non-executives recruitments are carried out mainly on regional level, a large number of SCs/STs and other weaker section of the society get the benefit of employment in SAIL. For jobs of temporary & intermittent nature, generally contractors deploy workmen from the local areas, which again provide an opportunity for employment of local candidates of economically weaker section.

Establishment of steel plants in economically backward areas has given a fillip to the economic activities thus benefiting the support population providing different types of services. Over the years, a large

group of ancillary industries has also developed in the vicinity of Steel Plants. This has created opportunities for local unemployed persons for jobs and development of entrepreneurship.

Growth over the years, the steel industry of India has seen tremendous but a steady growth, backed by many initiatives taken by Indian Government. Additional initiatives taken by Government, is proving to be helpful to boost economic growth, by injecting various funds in industry such as Infrastructure, Construction, Power and Automobiles. This growth impetus will definitely cater future growth of Indian steel industry. The prospective growth of the Indian steel industry not only attracts Domestic capital, but numerous other foreign global steel players have been planning to invest the market.

Notes

UNIT 1.2: Understanding various types of Iron & Steel Industry

Unit Objectives

At the end of this unit, you will be able to:

1. Understand about iron & steel industry structure
2. Know about iron & steel plants in India

1.2.1 Industry structure

The Iron and Steel Industry in India has 2 separate divisions:

- Integrated producers, and
- Secondary producers

Amongst the **Integrated producers**, the major producers include Tata Iron and Steel Company Limited (TISCO), Rashtriya Ispat Nigam Limited (RINL) and Steel Authority of India Limited (SAIL), who generate steel by converting iron ore.

The **Secondary producers** like Ispat Industries, Lloyds steel and Essar Steel, create steel through the process of melting scrap iron. These are mainly small steel plants and produce steel in electric furnaces, using scrap and sponge iron. They produce both mild steel and alloy steel of given specifications.

1.2.2 Major Iron and Steel Plants of India

List of Major Iron and Steel producing companies in India

1. Tata Steel (ranked 11th in the world in terms of production of steel)
2. Steel Authority of India (SAIL) – ranked 29th in the world.
3. JSW Steel Limited – ranked 31 in the world.
4. Essar Steel
5. Jindal Steel and Power
6. Mahindra Ugine Steel

Some of the major Iron and Steel Plants of India are as follows:

1. Tata Iron and Steel Company (TISCO):

This is the oldest iron and steel centre of India. It is a private sector enterprise. It was established in 1907 by Jamshedji Tata at Sakchi in Singhbhum district of Jharkhand. Later on, it was renamed as Jamshedpur after Jamshedji. It started producing pig iron in 1911 and steel in 1912.

The plant initially had capacity of producing 1.21 million tonnes of pig iron and 1.1 million tonnes of steel per annum. This capacity has been enhanced to 3.9 million tonnes of pig iron, 2 million tonnes of ingot steel and 3 million tonnes of saleable steel.

2. Indian Iron and Steel Company (IISCO)

Three plants at Kulti, Hirapur and Bumpur in West Bengal were set up in 1864, 1908 and 1937 respectively. These plants have been merged together and are known as Indian Iron and Steel Company (IISCO).

IISCO has annual capacity of producing 10 lakh tonnes of steel. Currently it produces over 4 lakh tonnes of pig iron, more than 3.5 lakh tonnes of crude steel and around 3.8 lakh tonnes of saleable steel.

3. The Visweswaraya Iron and Steel Ltd:

It was established as Mysore Iron and Steel Company (MISCO) in 1923 by the erstwhile state of Mysore. It is located at Bhadravati on the banks of river Bhadravati in Shimoga district of Karnataka. This plant was brought under state control in 1962 and was renamed as Visveswaraya Iron and Steel Ltd. after the name of great engineer Dr. Visweswaraya. This plant has got a capacity of 1.38 lakh tonnes of steel. There are plans to raise its capacity to two lakh tonnes.

4. Bhilai

Bhilai iron and steel centre was set up in Durg district of Chhattisgarh in 1957 with the technical and financial support of the then Soviet Union. It started production in 1959. Its initial capacity was 10 lakh tonnes which has been raised to 52 lakh tonnes.

5. Rourkela:

Plant of Hindustan Steel Limited at Rourkela is situated in the Sundargarh district of Orissa It was set up with the help of the then West German firm, Krupps and Demang, during t e Second Five Year Plan (West Germany and East Germany have united to form one country now). It became operative in 1959

There are more than 50 iron and steel industries in India their locations are given below in the table that follow

Name	Location	Owner
Tata Iron and Steel Corporation (TISCO)	Jamshedpur, Jharkhand	Tata Steel
Visvesvaraya Iron and Steel Plant	Bhadravati, Karnataka	SAIL
Bhilai Steel Plant	Chhattisgarh	SAIL
Durgapur Steel Plant	Durgapur, West Bengal	SAIL
Bokaro Steel Plant	Jharkhand	SAIL
Chandrapur Ferro Alloy Plant	Chandrapur, Maharashtra	SAIL
IISCO Steel Plant	Asansol, West Bengal	SAIL
Salem Steel Plant	Tamil Nadu	SAIL
Rourkela Steel Plant	Odisha	SAIL
Vijaynagar Steel Plant	Hospet, Bellary, Karnataka	Jindal Steel and Power
Vishakhpatnam Steel Plant	Vishakhapatnam, Andhra Pradesh	Rashtriya Ispat Nigam

Mini Steel Plants:

In addition to the integrated steel plants, a large number of decentralized secondary units produce steel by using steel scrap/sponge iron as raw material and electric arc furnace and induction furnace for processing. With capacity varying from ten thousand to five lakh tonnes, these are known as mini steel plants. It is easy to construct such plants and their gestation period is short.

Notes

UNIT 1.3: Creation of products in Iron & Steel Industry

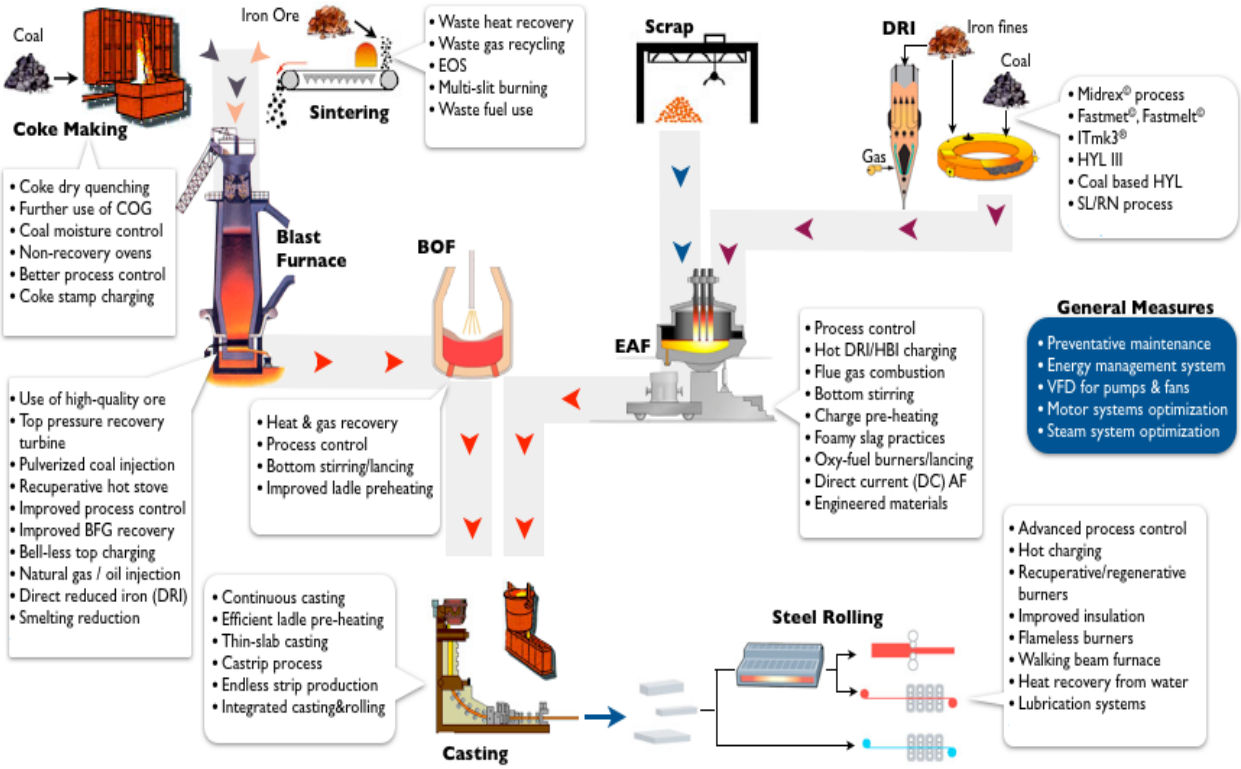
Unit Objectives

At the end of this unit, you will be able to:

1. Learn about steel making process
2. Learn about different processes involve in steel making

1.3.1 Steel making procedure

Steel production involves numerous process steps that can be laid out in various combinations depending on product mix, available raw materials and energy supply and investment capital. Key characteristics of the three main processing routes are as following:



1. In Blast Furnace (BF)/Basic Oxygen Furnace (BOF) route, pig iron is produced using primarily iron ore (70-100%) and coke in a blast furnace, and then turned into steel in a basic oxygen furnace. Due to the inclusion of coke making and sintering operations, this route is highly energy intensive.

2. Scrap/Electric Arc Furnace (EAF) route is primarily based on scrap for the iron input and has significantly lower energy intensity compared to the BF/BOF route due to the omission of coke making and iron making processes;
3. Direct Reduced Iron (DRI)/EAF route, based on iron ore and often scrap for the iron input. Energy intensity of DRI production can be lower than BF route, depending on the size, and fuel and ore characteristics.

1.3.2 Processes involve in steel making

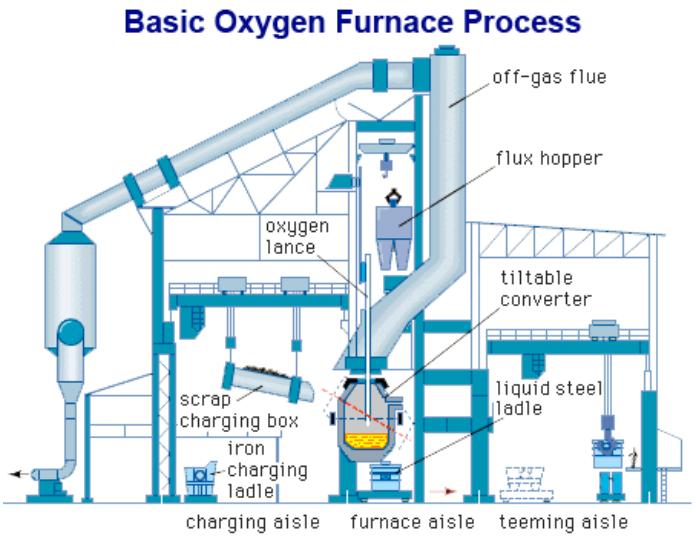
1. Coke Making

Coke is a material with high carbon content and porosity. It has high resistance to breakage and low reactivity with gases, particularly CO_2. Coke production is an important part of the integrated iron and steel plants using BF-BOF route, acting as a reducing agent, as a source of thermal energy, and providing physical support for the burden in blast furnace. Coke is produced by heating coking coals up to 1000 to 1200 °C for several hours in coke ovens to drive off volatile compounds and moisture.

2. Basic Oxygen Furnace

Basic Oygen Furncace (BOF) is a pear shaped vessel where the pig iron from blast furnace, and ferrous scrap, is refined into steel by injecting jet high-purity oxygen through the hot metal. More specifically, in a BOF:

- The carbon content of pig iron, which is typically 4-5%, is reduced to varying levels below 1% depending on the product specifications;
- Unwanted impurities are removed;
- Concentration of desired is brought to product specifications.
- The temperatures in the furnace usually reach 1600-1650 ^{o}C.

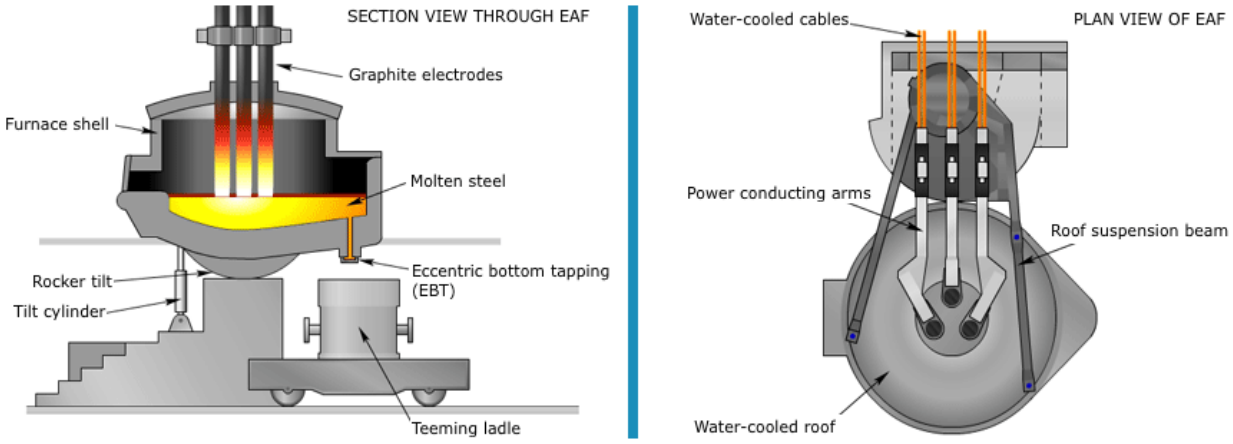


3. Electric Arc Furnace

Electric Arc Furnaces (EAFs) are a central part of the production route that is an alternative to the dominant BF-BOF route. EAFs are used to produce carbon steels and alloy steels primarily by recycling ferrous scrap. In an EAF scrap and/or manufactured iron units – such as DRI, pig iron, iron carbide – is melted and converted into high quality steel by using high-power electric arcs formed between a cathode and one (for DC) or three (for AC) anodes.

The iron units are loaded in a basket together with limestone – for slag formation – and charged into the furnace. The main task of most modern EAFs is to convert the solid raw materials to liquid crude steel as fast as possible and then refine further in subsequent secondary steelmaking processes.

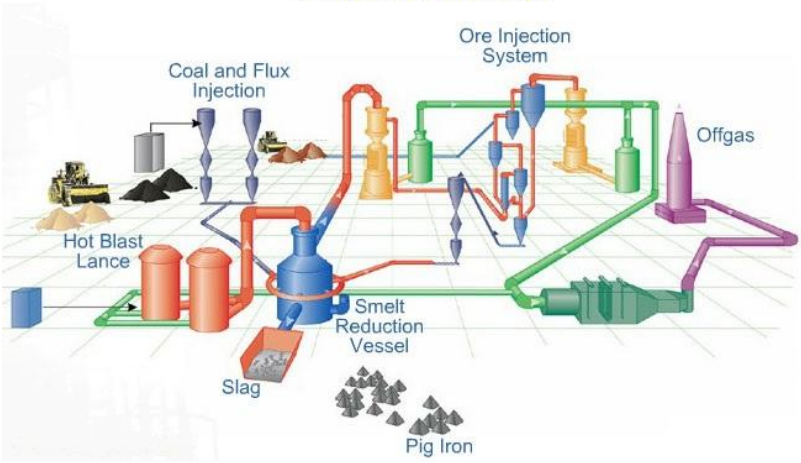
Section and Plan View of Electric Arc Furnace



4. Smelting Reduction

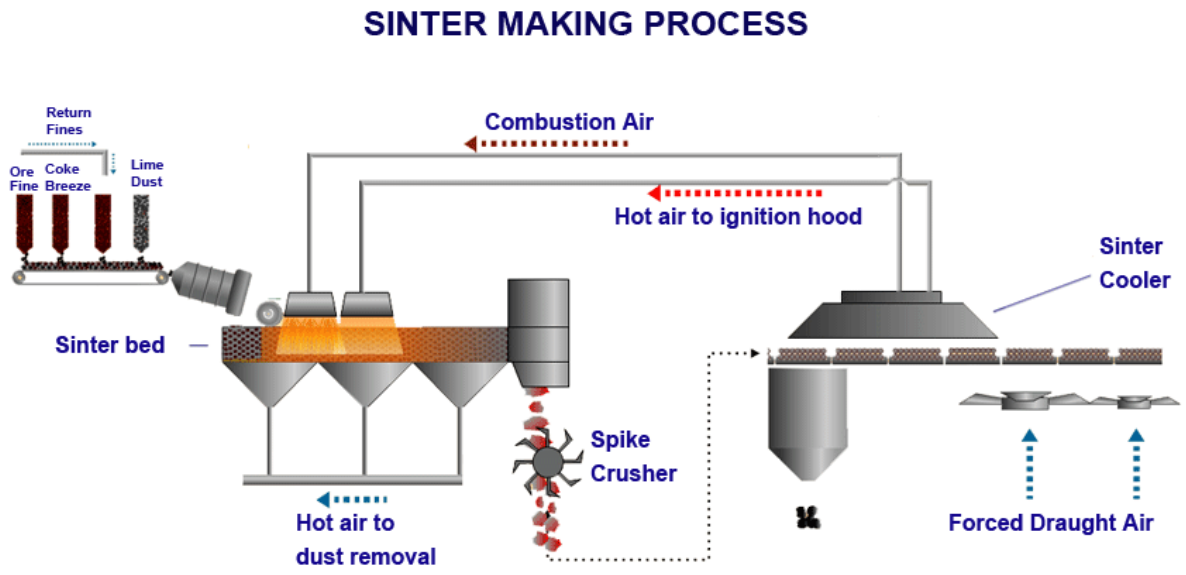
Smelting reduction processes are the latest development in pig iron production. These processes combine the gasification of coal with the melt reduction of iron ore. Energy intensity of smelting reduction is lower than that of blast furnace.

Smelting Reduction Plant Layout
(Using HIsmelt Technology)



5. Sinter Plant

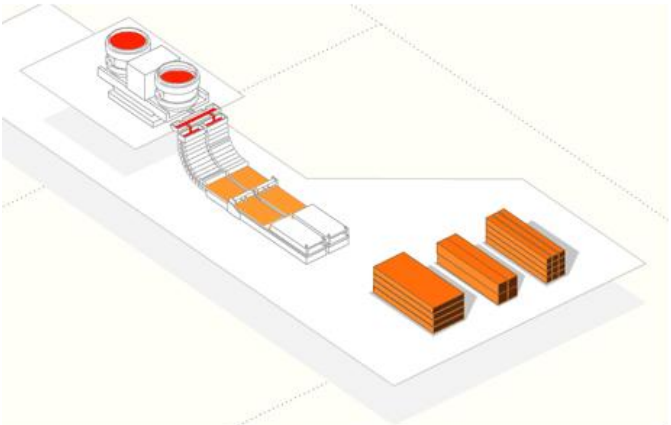
The purpose of the sinter plant is to process fine grained raw materials into a coarse grained iron ore sinter, ready to be charged to the blast furnace. Sintering of fine particles into a porous clinker – sinter – is necessary to improve the permeability of the burden, making reduction easier. A high quality sinter has high reducability, which reduces the intensity of blast furnace operations and reduces coke demand.



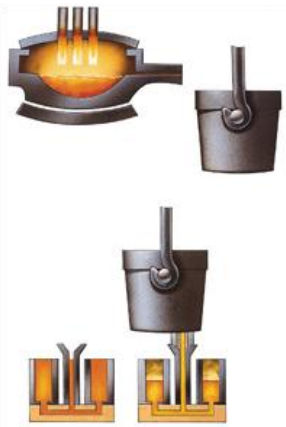
6.

Casting

A wide variety of processes that can be part of finishing are grouped under casting and shaping (rolling). Casting is a stage in finishing operations where the hot metal with the right properties is turned into intermediate, marketable products. Casting can be done as a batch (producing ingots) or continuous (producing slabs, blooms or billets) process. In most mills, casting is performed in continuous casting machines and the significantly low share of ingot casting is mainly used for specialty products.



Continuous Casting

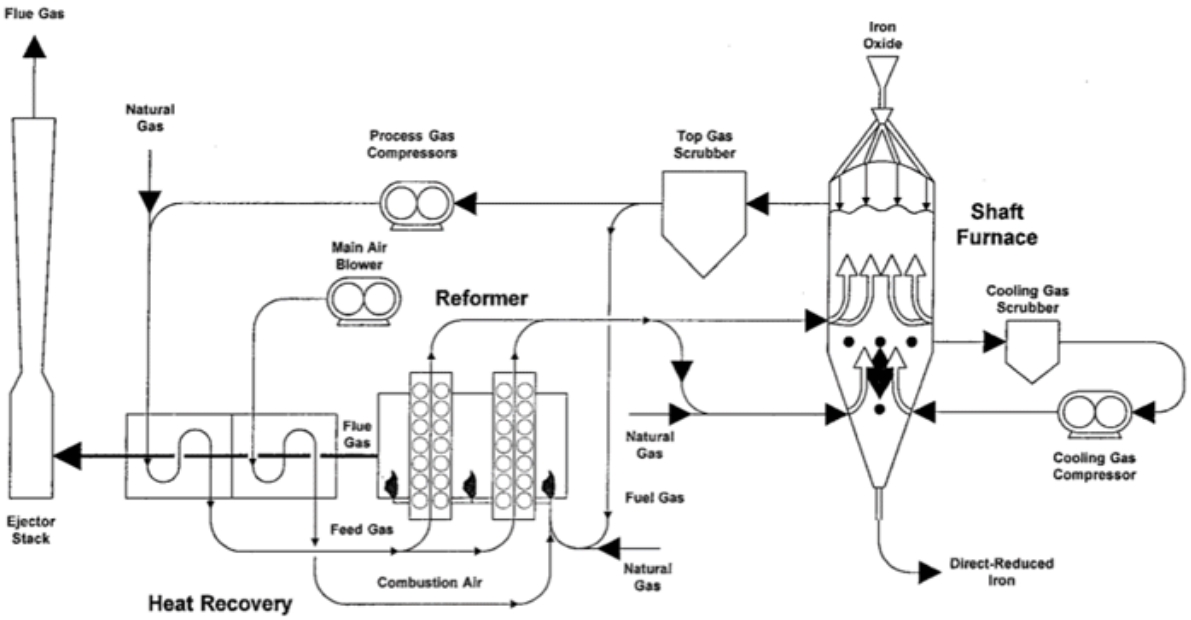


Ingot Casting

7. Direct Reduced Iron

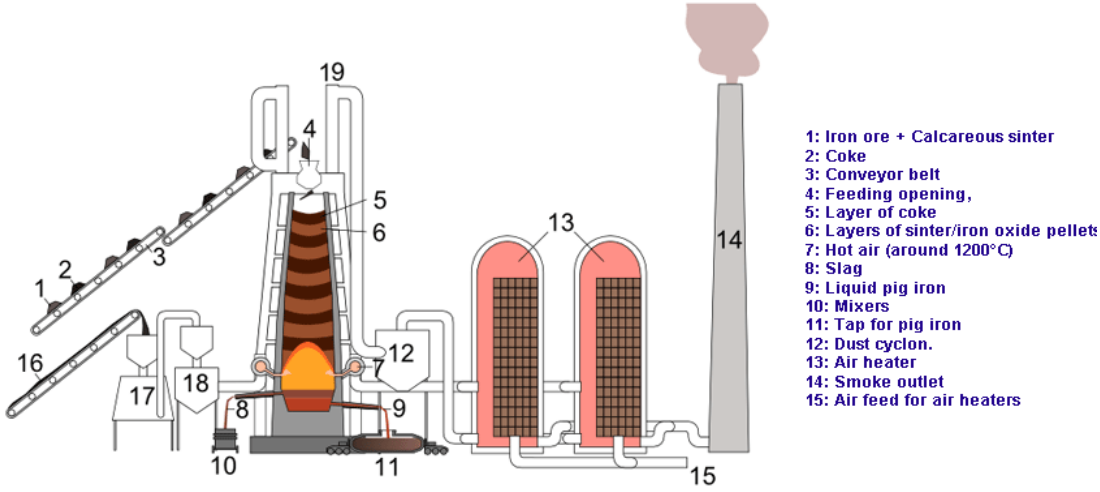
Direct Reduced Iron (DRI), also known as Sponge Iron, offers an alternative steel production route to BF-BOF and Scrap-EAF routes. In DRI, iron ore is reduced in its solid state – unlike BF process where a liquid metal is formed during reduction. DRI can then be transformed to steel in electric arc furnaces.

8.



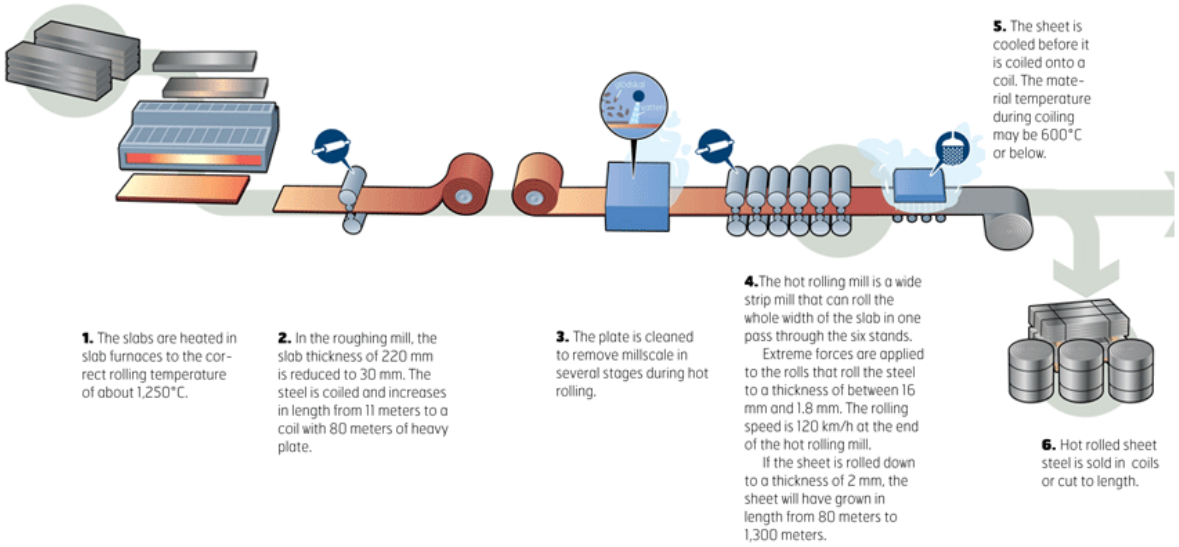
Blast furnace system

In a blast furnace (BF) the iron oxides are reduced and the resulting iron is melted. Approximately 70% of the global steel production involves the use of BFs. Sizes of BFs installed cover a very wide spectrum, ranging from less than 100 m^3 to more than 5000 m^3. Larger BFs have less heat losses and enable installation of heat recovery equipment more cost effectively.



9. Rolling Mills

In rolling mills, intermediate steel products are given their final shape and dimension in a series of shaping and finishing operations. Most of the slabs are heated in reheating furnaces and rolled into final shape in hot– or cold–rolling or finishing mills.



1. The slabs are heated in slab furnaces to the correct rolling temperature of about 1,250°C.

2. In the roughing mill, the slab thickness of 220 mm is reduced to 30 mm. The steel is coiled and increases in length from 11 meters to a coil with 80 meters of heavy plate.

3. The plate is cleaned to remove millscale in several stages during hot rolling.

4. The hot rolling mill is a wide strip mill that can roll the whole width of the slab in one pass through the six stands.

Extreme forces are applied to the rolls that roll the steel to a thickness of between 16 mm and 1.8 mm. The rolling speed is 120 km/h at the end of the hot rolling mill.

If the sheet is rolled down to a thickness of 2 mm, the sheet will have grown in length from 80 meters to 1,300 meters.

5. The sheet is cooled before it is coiled onto a coil. The material temperature during coiling may be 600°C or below.

6. Hot rolled sheet steel is sold in coils or cut to length.

Notes

2. Job Understanding Requirement

Unit 2.1 – Understand the job assigned

Unit 2.2 - Understanding the engineering drawings

Unit 2.3 - Using of conveyor belt and its parts

Unit 2.4 – Identify the tools

Unit 2.5 - Diagnosing the common defects and tackling them

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know about the roles and responsibilities as per the job description.
2. Know about the engineering drawing basics.
3. Know how to diagnose the defects.

Unit 2.1: Understanding the Job Assigned

Unit Objectives

At the end of this unit, you will be able to:

1. Understand the your job being a belt conveyor maintenance person
2. Interpret the checklist and understand the job requirements
3. Plan, as appropriate to carry out the job

2.1.1. Understanding the job

General

Most accidents causing personal injury can be traced to unsafe work practices by either operating or maintenance personnel. Many accidents occur because the personnel concerned do not realize the danger of improper practices.

Maintenance personnel can contribute greatly towards the success of a safety program. They are familiar with product processing equipment and know the dangers inherent in such equipment.

In addition, they realize the hazards resulting from incorrect use of the equipment.

Maintenance personnel should be trained to recognize and report promptly unsafe practices in the operational use of this equipment, as well as any dangerous condition in the equipment itself.

Facilities every industry in the world have equipment that helps to run their daily operations. No matter how well manufactured the equipment, routine check ups and maintenance is mandatory—whether it's conveyor or an air conditioner. Even the most durable, long-lasting conveyors, conveying equipment and accessories need maintenance.

Benefits of maintenance

- Your conveyors will have extended life and run more reliably if you implement simple procedures designed to ensure that the equipment continues to perform for many years.
- Also, as all industries are closely monitoring energy consumption, lost work time and the overall sustainability of their operations, few things can cost your operation time, energy and money than a poorly maintained piece of equipment.

2.1.2. Checklist

Here are a few routine maintenance checkpoints that we recommend you use within your own facility. However, please follow all local, state, Federal and OEM safety guidelines when performing any safety or maintenance evaluations or work.

Each item reflects a part of the conveyor, what should be done, and how often. If your maintenance

department isn't already on a schedule like this one, it should be. There are also contractors who will independently do this maintenance.

Component	Suggested Action	Frequency
Motor	Check Noise	Monthly
	Check Temperature	Weekly
	Check Mounting Bolts	Monthly
Reducer	Check Noise	Monthly
	Check Temperature	Monthly
	Check Oil Level	Quarterly
Drive Chain	Check Tension	Quarterly
	Lubricate	Weekly
	Check for Wear	Quarterly
Sprockets	Check for Wear	Quarterly
	Check Set Screws & Keys	Quarterly
Belt	Check Tracking	Monthly
	Check Tension	Monthly
	Check Lacing	Weekly
Bearings - *pulleys and rollers*	Check Noise	Monthly
	Check Mounting Bolts	Quarterly
V-belts & O-rings	Check Tension	Monthly
	Check for Wear	Monthly
	Check Sheave Alignment	Monthly
Structural	General: Check all bolts for tightness	Monthly

Conveyor Maintenance Checklist

While the system is in operation, check the following issues and refer to all relevant safety warnings and information:

- Regularly walk around both sides of the system and note the condition, as well as any unusual behavior of all the moving components.
- Note points of material buildup.
- Look for any signs of misalignment or improper belt tracking.
- Check drive amperage requirements and compare amperages to previous levels for similar loads and conditions.

'''Note''': A rise in amperage levels above previous levels may be an indication of increased drag within the system, perhaps due to failed or unlubricated bearings. This should be further investigated when the system is at rest and electrically locked out.

Check the following while the system is at rest and electrically locked out:

- Confirm that components are in proper alignment and make necessary adjustments.

- Closely inspect suspect components and take corrective action as appropriate (i.e., if rolls are not revolving freely, relubricate or replace).
- Check all safety systems.
- Test control equipment.
- Check for belt wear — especially at edges and splices — and belt stringing.
- Check for damage or wear at loading and transfer points.
- Check clearances at chute and skirting areas.
- Remove any material buildup on components and clean up any spills along the system.
- '''Note''': The causes of such should be investigated and corrected.
- Relubricate all pillow block bearings per the manufacturer's schedule or the specific requirements of the installation.
- If relubricatable, relubricate troughing and return rolls per the manufacturer's schedule or the specific requirements of the installation.
- Check the condition and functionality of belt scrapers, and adjust or replace as needed.
- Confirm that all guards and covers are in place.
- Replace motor brushes as specified by the manufacturer.

2.1.3 Precautions

Precautions for Operating Personnel

The following precautions must be observed:

- Do not operate the conveyor without the motor guards in position.
- Stop the conveyor before clearing jams or removing foreign objects.
- Make sure all personnel are clear of moving parts before starting the conveyor.
- Make sure only authorized, trained personnel operate the conveyor.
- Do not wear loose clothing or accessories where such clothing may be caught in moving parts of the conveyor.
- Do not eat food or drink when operating the conveyor.
- Do not smoke when operating the conveyor.
- Avoid distractions when operating the conveyor.
- Never place hands in moving parts when the conveyor is operating. Never touch a moving belt.
- Keep conveyor fully retracted when not in use with the belt stopped.

Precautions for Maintenance Personnel

The following precautions must be observed:

- Do not perform maintenance while the conveyor is operating. Lock out the circuit breaker disconnect switch with personal padlocks on the conveyor before performing maintenance. For belt tracking or listening for bearing noise, never touch a moving belt, roller, pulley, or bearing. All inspections and adjustments can be made from outside the conveyor. Never reach under or into the conveyor when the belt is running.
- Before restarting the conveyor, make sure all personnel are clear of moving parts.

- Maintain good housekeeping in the vicinity of the conveyor at all times. Clean up spilled materials or lubricants promptly.
- Always replace the safety guards and protective devices before putting the conveyor back in service. Do not run the conveyor with the chain drive guards open or missing.
- Maintenance personnel should be alert for hazardous conditions at all times. Remove sharp edges and protruding objects and replace broken or worn parts promptly.
- When using air hoses and drop cords, string them to avoid creating a tripping hazard.
- Always stop the conveyor to clear jams or to remove foreign objects.
- Use the proper tool for each job. Carry tools in a pouch or a tool box. Never carry tools in pockets.
- Wear goggles while using compressed air.
- Do not direct the stream of air toward yourself or other workers.
- Do not use compressed air to clean yourself or your clothing.
- Horseplay with compressed air is extremely dangerous.
- Do not smoke while using solvents or cleaning fluids.
- Report all accidents resulting in personal injury or damage to equipment or material, and all irregularities in equipment operation, promptly to the proper authority.

Unit 2.2: Understanding the engineering drawing

Unit Objectives

At the end of this unit, you will be able to:

1. Know about basics of engineering drawing
2. Know about orthographic projection views
3. Know about concept of quadrants
4. Know about engineering standards
5. Know about tools require for engineering drawing

2.2.1 Basic knowledge of engineering drawing

Engineering drawing: It is a graphical language used by engineers and other technical personnel associated with the engineering Profession. The purpose of engineering drawing is to convey graphically the ideas and information necessary for the construction or analysis of machines, structures, or systems.

These are detailed drawings drawn accurately and precisely. They are pictures that have been prepared with the aid of mathematical instruments in order to record and transmit technical information. They provide an exact and complete description of things that are to be built or manufactured.

- Technical drawings do not portray the objects the way they directly appear to the eye.
- They make use of many specialized symbols and conventions in order to transmit technical information clearly and exactly.
- To understand and correctly interpret technical drawings, one needs to acquaint oneself with the fundamentals of technical drawing – hence the purpose of this course.

2.2.1.1 Presentation of engineering drawing

In basic engineering drawing, orthographic projection method is used. Here in welding industry to communicate technical information through engineering drawing, we usually utilize orthographic views (OV) rather than pictorial views.

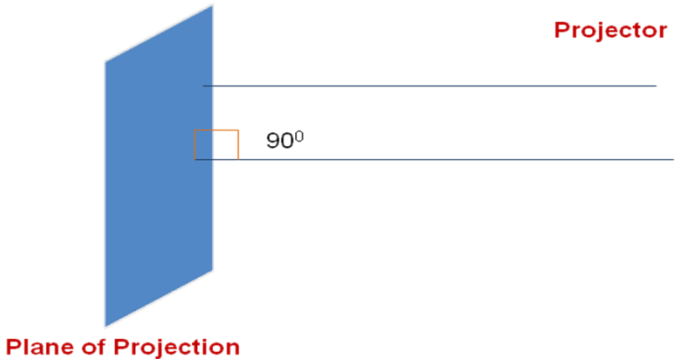
- Orthographic (OV) help to record the shapes of objects exactly and completely
- OV is a two-dimensional (2-D) drawing. It shows only one side of an object and two of its overall dimensions
- A minimum of two OV is required to show the three dimensions of any object and therefore to describe its shape completely

So, here we are going to only study about orthographic projections.

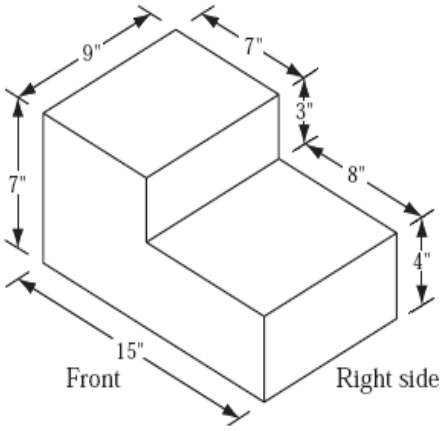
2.2.1.2 Orthographic projection

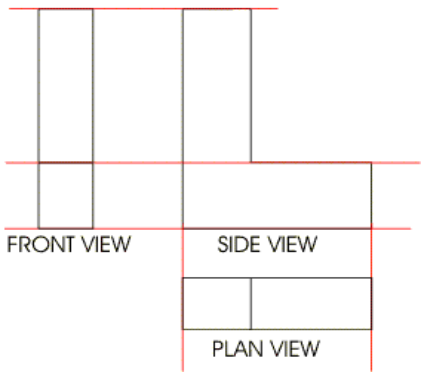
Accurate orthographic drawings are the foundation of all construction drawings. They furnish complete information for construction and repair, as well as present an object in its true proportions as to shape and size. The orthographic projection shows the object as it looks from the front, right, left, top, bottom, or back, and are typically positioned relative to each other according to the rules of either first-angle or third-angle projection. Third angle orthographic projection is the standard for all mechanical drawings.

Orthographic projection is the method of representing the exact shape of an object in two or more views, on planes generally at right angles to each other, by extending perpendiculars from the object to the planes.



One of these views is referred to as the “plane” or top view and represents the object as it appears from directly overhead. Another is known as the “elevation” or front view and represents the object as it appears directly from the front. Still another, designated as “side elevation” or side view, supplements the top and front views by giving information not given in these views.

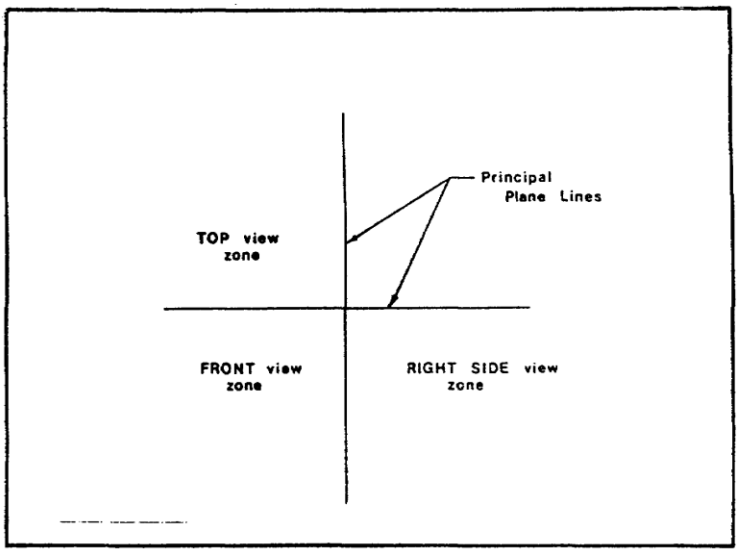




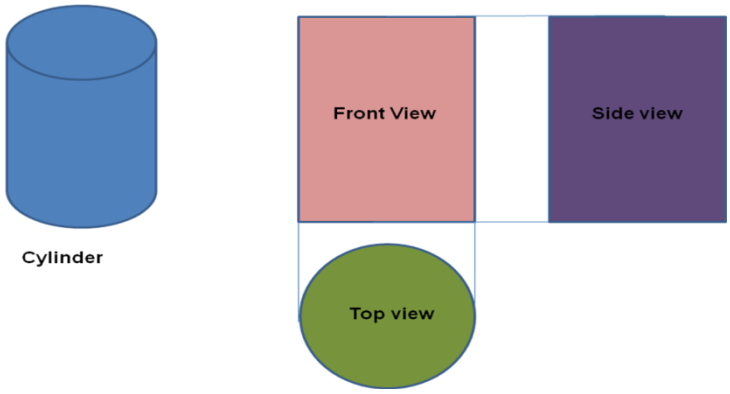
View arrangement: Study the arrangement of the three views in figure. The front view is the starting place. It was selected for the front view because it shows the most characteristic feature of the object. The right side view is projected directly to the right of the front view. Notice that the top view is placed

directly above the front view and that some of its lines lie along extensions of lines from the front view. After studying each view, try to imagine or visualize the appearance of the object.

Principal Plane Line: Drawings are divided into zones. Each zone contains one orthographic view, together with all information pertinent to that view. The zones are separated by crossed (90°) construction lines called principal plane lines which are similar to a mathematical coordinate system. They are omitted on finished drawings, but their presence is understood. Principal plane lines are defined in figure.



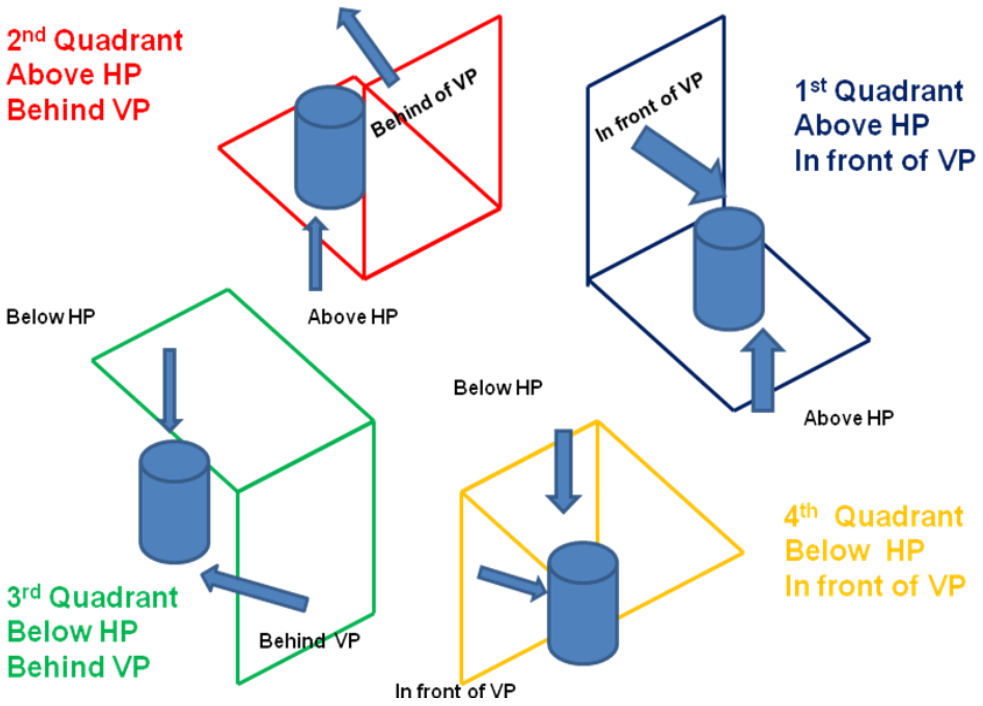
For example: Orthographic views of a cylinder are



To understand how to draw these views, first we need to understand the planes of projection and concept of quadrants.

2.2.1.3 Concept of Quadrants

See the projection of cylinder in all the four quadrants as shown

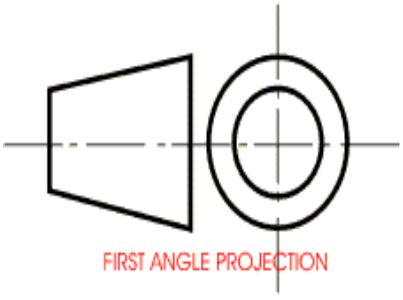


- If we imagine the projection in 1st quadrant, then it is called 1st angle projection.
- If we imagine the projection in 2nd quadrant, then it is called 2nd angle projection.
- If we imagine the projection in 3rd quadrant, then it is called 3rd angle projection.
- If we imagine the projection in 4th quadrant, then it is called 4th angle projection.

For basic engineering drawings two standards are commonly in use in orthographic projection of drawings; the 1st angle Projection (European projection) and the 3rd angle Projection (American projection). It should be noted that corresponding views are identical in both methods of projection except for their relative positions on the drawing paper. So, let's understand them:

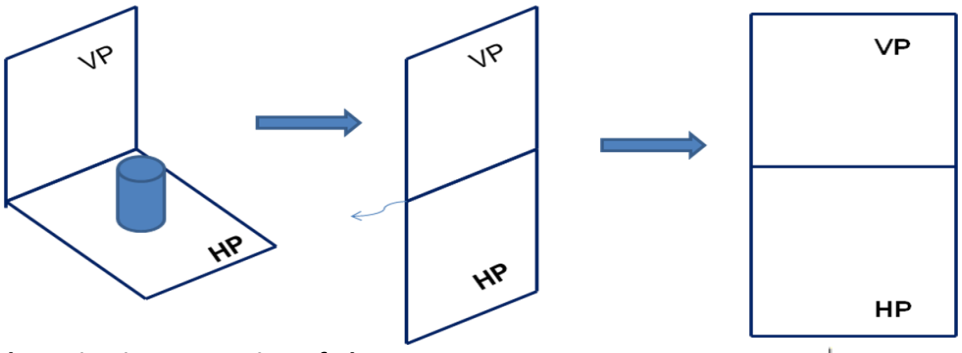
1st angle Projection – Rotation of Planes

Here, the front view (A) is the basis (reference) and the other views are drawn as 'shadows' of that view. That is, the left hand side view for instance is drawn on the right side of the front view. Similarly the top view (plan) is drawn at the bottom of the front view, etc.



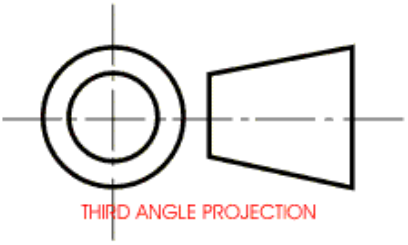
Step 1: Rotate the Horizontal Plane Clockwise through $90^{0.}$

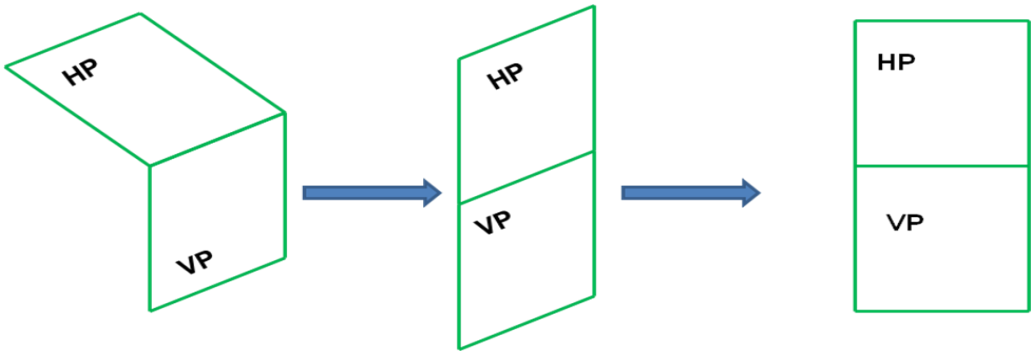
Step 2: Rotate the planes clockwise through 90^{0} to face the observer.



3rd angle Projection – Rotation of Planes:

Here, the front view is the basis (just as before) but the other views are drawn as 'reflections' of that view. The left hand side view is drawn on the left hand side of the front view. Similarly, the top view (plan) is drawn at the top of the front view.

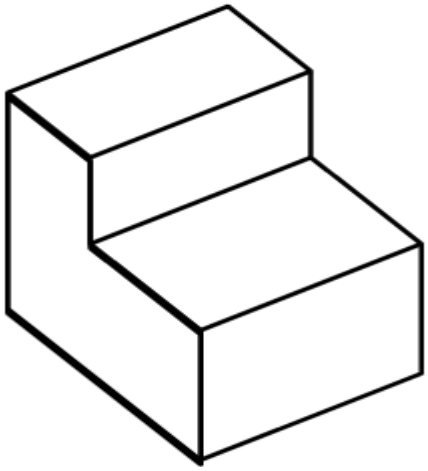




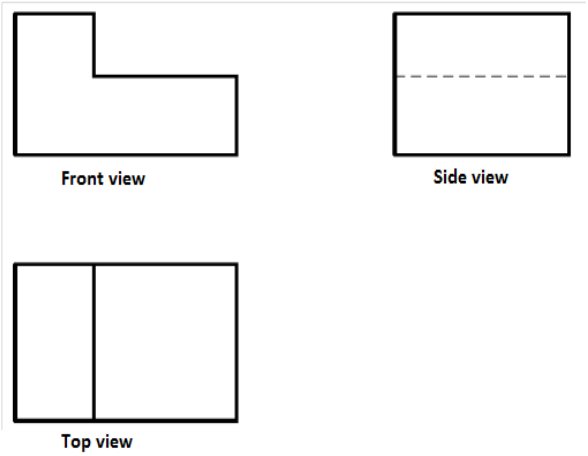
Step 1: Rotate HP through 90^0 in the clockwise direction

Step 2: Rotate the planes through 90^0 in the clockwise direction to face the observer

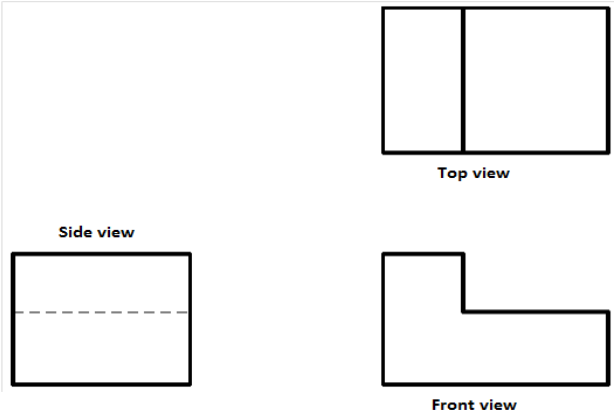
For example: The Front View (FV), Left Hand Side View (LHSV) and Top View (PLAN) of the given object



In 1st angle projection is:



In 3rd angle projection is:



2.2.1.4 Tips for drawing the sketches

A systematic order of application should be followed for both idea sketches and sketches from objects. It is outlined as follows:

- **Visualize Object**: This is essential so that the mental image is definite and clear and a good graphical description can be developed.
- **Determine Views:** The views may or may not be the same as for a scale drawing, depending upon the purpose of the sketch; e.g., a note in regard to the thickness or shape of the section will often be used to save a view.
- **Determine Size**: A sketch should be in proportion to the sheet of paper. It should be large enough to show all detail clearly, but allow plenty of room for dimensions, notes, and specifications.
- **Locate Center Lines**: Always locate the center lines first when beginning a sketch.

- **Block in Main Outlines:** Watch carefully the proportions of width to height in this step. Select one edge as a unit from which to estimate the proportionate lengths of the other edges.
- **Complete Detail:** After the main outline is satisfactory, fill in the details in correct proportion.
- **Dimension Lines and Arrowheads**: When the shape of the object has been completely described, the dimension lines and arrowheads should be added. No measurements are taken until this step is completed.
- **Dimensions:** Now the sketch is ready to have dimensions inserted on it. These dimensions are obtained with a rule or a steel cable. All measurements should be taken from finished surfaces.
- **Titles and Notes:** These should be inserted together with the date so that, in the case of new inventions, it is possible to prove priority.
- **Check:** The sketch should be given a final check. Be sure this is done very carefully.

2.2.2 Engineering Drawing Standards

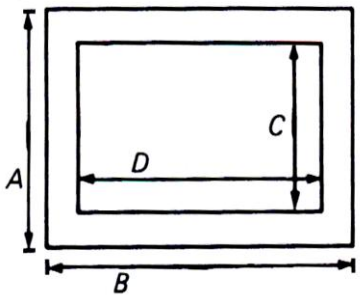
Engineering drawings, being one of the many forms of technical communication, have to fulfill some accepted standards. There are various national, multinational and international standards, but the current trend in most countries is to adhere (adopt) the ISO standards.

What are Drawing Standards?

- Following Standards help in easy understanding of drawings across the country
- Bureau of Indian Standards (BIS) provides the standards for technical drawings
- Examples
    - IS 919 (Part 2) : ISO system of limits and fits
    - IS 10714 : General principle of presentation o technical drawings
    - IS 10718 : Method of dimensioning and tolerance cones on drawing

2.2.2.1 Drawing Sheet Sizes

The ISO most recommended paper sizes for technical drawings are known as **A-FORMATS**. Other series, like the B-Series, are of lesser importance. In the A-Format series, the largest size is A0. The size of an A1 paper is half the size of A0 while A2 is half the size of A1 and so forth. Smaller-sized A format papers (i.e. A5, A6, etc) are very rarely used for technical drawings.

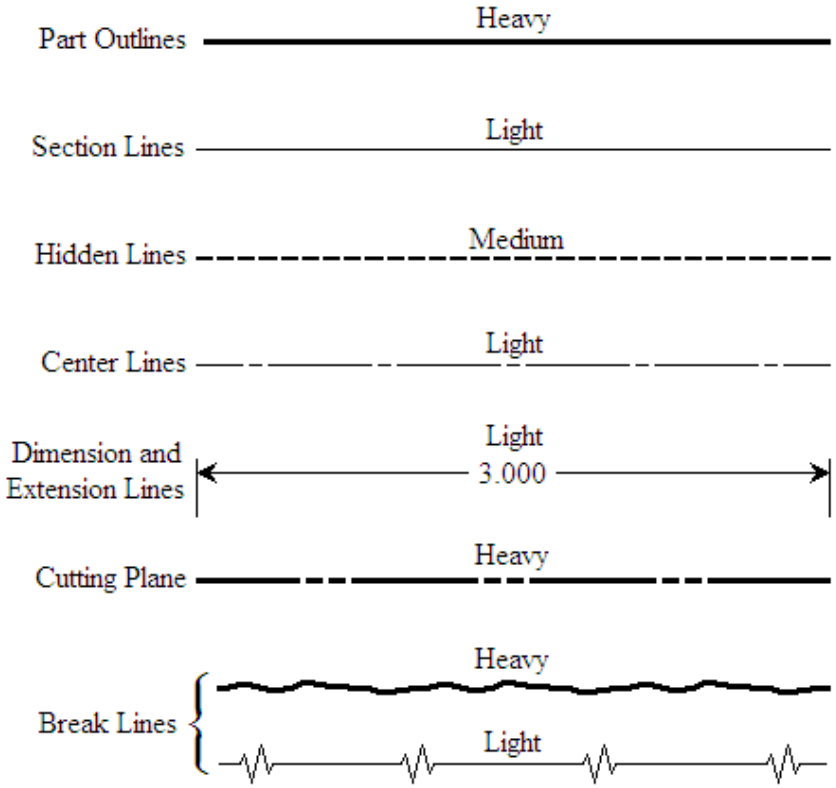


Designation	Size of the Sheet		Size of Frame	
	A (mm)	B(mm)	C(mm)	D(mm)

A0	841	1189	791	1139
A1	594	841	554	804
A2	420	594	380	554
A3	297	420	267	390
A4	210	297	180	267
A5	184	210		

2.2.2.2 Lines

In Engineering Drawing, we make use of different lines and line styles to convey the desired message. These lines differ in (i) thickness and (ii) style. Typical uses of these lines are summarized below.



- **Visible** – are continuous lines used to depict edges directly visible from a particular angle?
- **Hidden** – are short-dashed lines that may be used to represent edges that are not directly visible.
- **Center** – are alternately long- and short-dashed lines that may be used to represent the axes of circular features.

- **Cutting plane** – are thin, medium-dashed lines, or thick alternately long- and double short-dashed that may be used to define sections for section views.
- **Section** – are thin lines in a pattern (pattern determined by the material being "cut" or "sectioned") used to indicate surfaces in section views resulting from "cutting." Section lines are commonly referred to as "cross-hatching."
- **Phantom** - are alternately long- and double short-dashed thin lines used to represent a feature or component that is not part of the specified part or assembly? E.g. billet ends that may be used for testing, or the machined product that is the focus of a tooling drawing.

2.2.2.3 Dimensioning

The required sizes of features are conveyed through use of *dimensions.* Distances may be indicated with either of two standardized forms of dimension: linear and ordinate.

- With ***linear*** **dimensions**, two parallel lines, called "extension lines," spaced at the distance between two features, are shown at each of the features. A line perpendicular to the extension lines, called a "dimension line," with arrows at its endpoints, is shown between, and terminating at, the extension lines. The distance is indicated numerically at the midpoint of the dimension line, either adjacent to it, or in a gap provided for it.
- With ***ordinate*** **dimensions**, one horizontal and one vertical extension line establish an origin for the entire view. The origin is identified with zeroes placed at the ends of these extension lines. Distances along the x- and y-axes to other features are specified using other extension lines, with the distances indicated numerically at their ends.

2.2.3 Basic drawing tools and equipments

Drawing board: A drawing board (also drawing table, drafting table or architect's table) is, in its antique form, a kind of multipurpose desk which can be used for any kind of drawing, writing or impromptu sketching on a large sheet of paper or for reading a large format book or other oversized document or for drafting precise technical illustrations.

Drafter: A min drafter is a very useful tool in technical drawing, consisting of a pair of scales mounted to form a right angle on an articulated protractor head that allows an angular rotation.

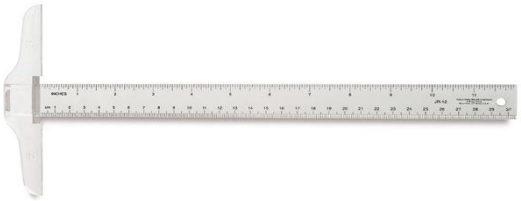
The protractor head (two scales and protractor mechanism) is able to move freely across the surface of the drawing board, sliding on two guides directly or indirectly anchored to the drawing board. These guides, which act separately, ensure

the movement of the set in the horizontal or vertical direction of the drawing board, and can be locked independently of each other.

Stationary items: You also require some stationary items like pencil, rubber and sharpener also.

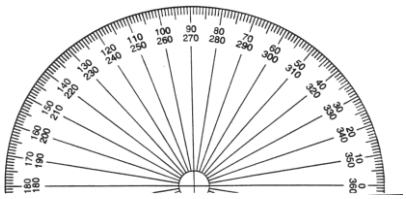
Type of Line	Type of Pencil to be used
Object outlines	HB
Dimension Lines	2H
Break Line	2H
Zig Zag and longer break lines	2H

T-Square and Triangles: A T square is used as a guide for drawing horizontal lines and as a support for the triangles which, in turn, are used as guides for drawing vertical and inclined lines. To use a T square or triangle as a guide for drawing lines, pull the pencil along the edge of the straight edge from left to right. Rotate the pencil as you draw so that a flat spot will not form on the lead. Flat spots cause wide, fuzzy lines of uneven width. Always remember to keep your drawing lead sharp.

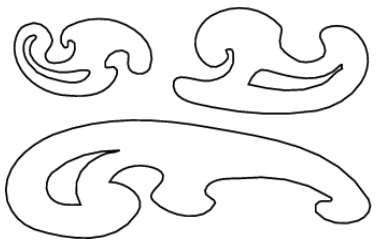


Compass: A compass is used to draw circles and arcs. To use a compass, set the compass opening equal to the radius of the desired circle or arc by using a scale. Then place the compass point directly on the circle center point and, using only one hand, draw in the circle.

Protractors: A protractor is used to measure angles. To measure an angle, place the center point of the protractor on the origin of the angle so that one leg of the angle aligns with the 0° mark on the protractor. Read the angle value where the other leg of the angle intersects the calibrated edge of the protractor.



Curves: Curves are used to help draw noncircular curved shapes. Draftsmen refer to them as French curves or ship's curves, depending on their shapes. Noncircular shapes are usually defined by a series of points and a curve is used to help join the points with a smooth, continuous line.



Unit 2.3: Use of conveyor belt and its parts

Unit Objectives

At the end of this unit, you will be able to:

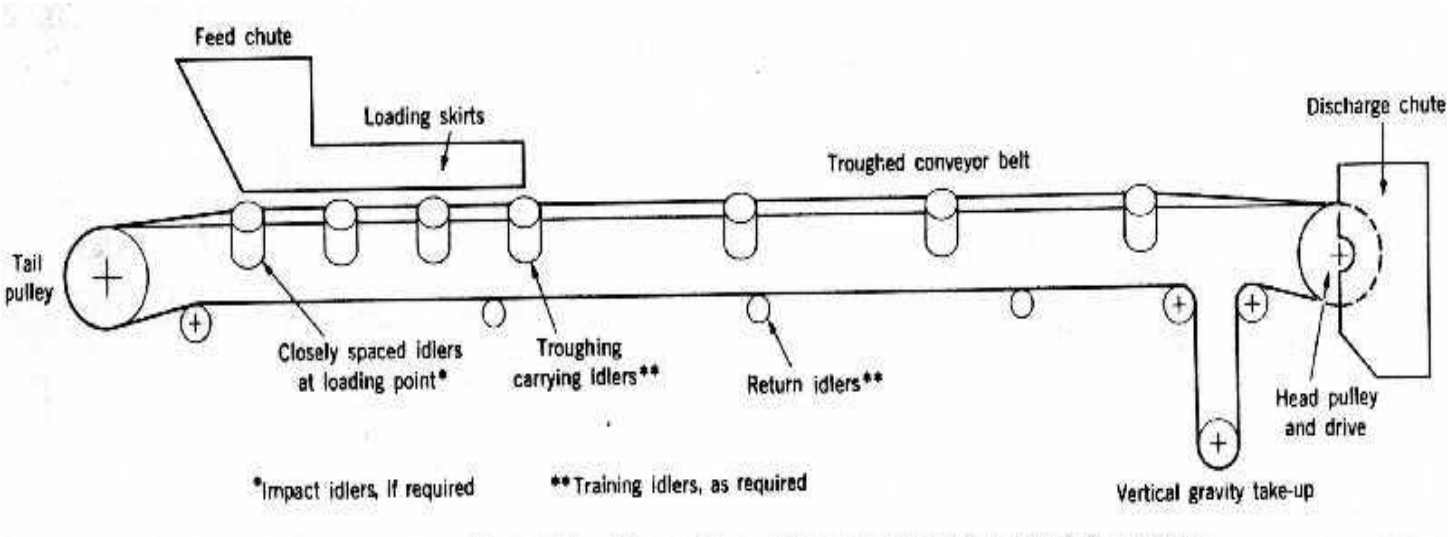
1. Know about conveyor belts
2. Know about various components of conveyor belt

2.3.1 About Conveyor

Components of Conveyor Belt

- Long Continuous belt
- Carried on rolls - rollers held by frame
- Belt wrapped around pulleys at ends
- Pulleys coupled to gears and motors
- Peripheral Devices to drop on belt, direct around corner, clean, discharge etc.

Conveyor Belt Parts

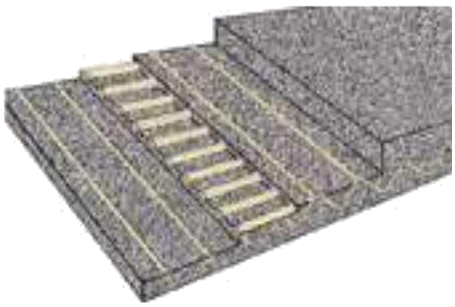


How Conveyor Functions

- Material Falls on moving belt that carries it along
- A continuous haulage system that is not limited by cycles of batch movement
- Requires a continuous frame and structure before can transport material over route
- Belt may ride on a frame with air holes - a compressor blows air under belt. Belt rides on a cushion of air.
- Rollers wrap belt entirely around material - used to allow vertical conveying of material

Types of Conveyor Belt

Belts According to Carcass



❶ Textile Belts

❶ Cotton Fabric Belts
❷ Polyamide Fabric Belts
❸ Polyester Fabric Belts
❹ Aramid Fabric Belts
❺ Rip Stop Belt

❷ Steel Belts

❶ Steel Rope Belts
a) Steel Cord Belt with Metal Weft
b) Steel Cord Belt with Textile Weft
❷ Steel Cord Fabric Belts

Belts According to Cover

❶ Type A - Abrasion Resistant

Cement Works: Quarries, open storage and reclamation, preblending. **Ports:** Ship loading or unloading installations . **Quarries:** Primery and secondary conveyors. **Public Works:** Boring, tunneling earthmoving. **Electricity Generating Stations:** Pre-blending, feed to hoppers, open storage and reclamation. **Sugar Mills:** Handling of raw beets. **Pulp Mills:** Handling of logs. **Coal Mines:** Tipping, refilling, washing. **Steel Works:** Iran ore hanling, open storage and reclamation, sinter plant, blast furnace feed, slag recovery.

❷ Type F - Flame Resistant

Underground Coal Mines.

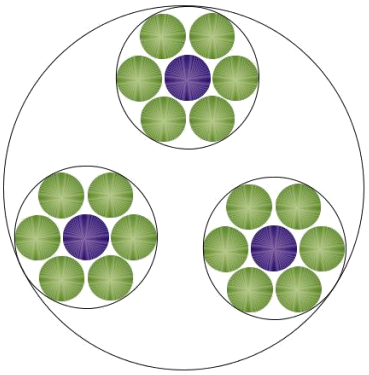
Belts According to Steep Angle

❶ Conveyor belts with no surface partitioning.
❷ Piece goods conveyor belts with cover patterning.
❸ Belts with chevron cleats.
❹ Box – section belts with corrugated sidewalls.
❺ Conveyor belts in sandwich design.
❻ Elevator belts.

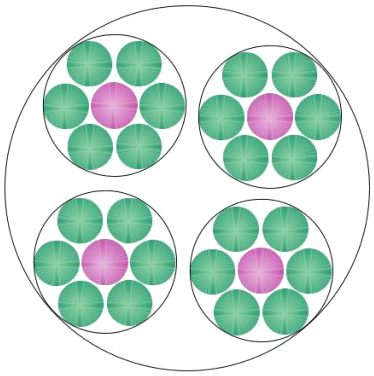
SOME COMPERATIVE PHYSICAL AND CHEMICAL PROPERTIES OF CARCASS

Material Types ▶ / ▼ Specifications	COTTON	RAYON	POLYAMİDE	POLYESTER	ARAMİD	STEELCORD
Density (g/cm3)	1,54	1,53	1,14	1,38	1,44	7,85
Decomposition temp./Melting Point °C	230	200	P.6. : 215 P.6.6. : 255	260	500	1600
Tenacity (mN/tex)	150	500	820	820	1950	330
Elongation At Break (%)	7	14	20	13	3,3	1,9
Hot Air Shrinkage (4 min. 160°C) (%)	0	1	4	5,5	0,1	0
Heat Resistance (48 h, 200°C) (%)	0	20	45	55	90	100
Resistance To Acids	poor	poor	fair	good	fair	fair
Resistance To Alkalis	good	fair	good	fair	good	very good
Resistance To Solvents	good	good	good	good	very good	very good

Steel Cord Constructions (for TW – IW – SW types)

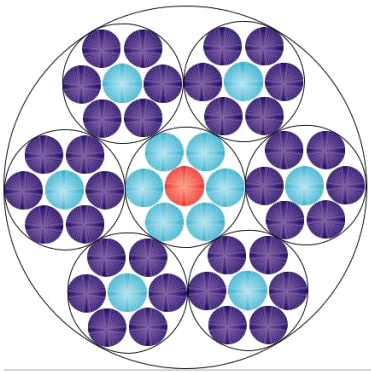


3 x 7

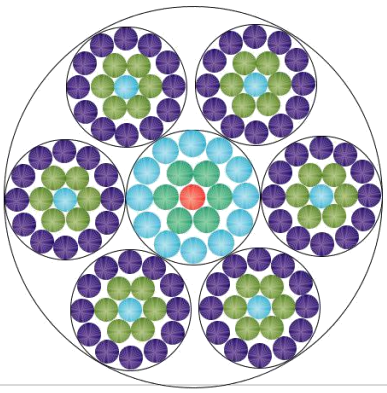


4 x 7

Steel Rope Constructions (for IWR type)

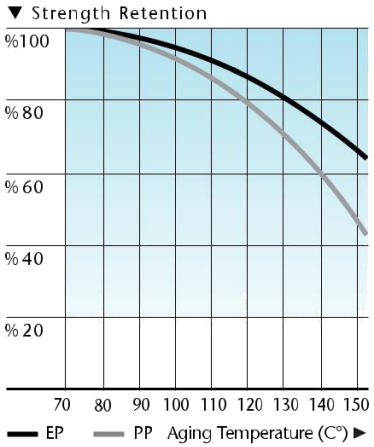


7 x 7

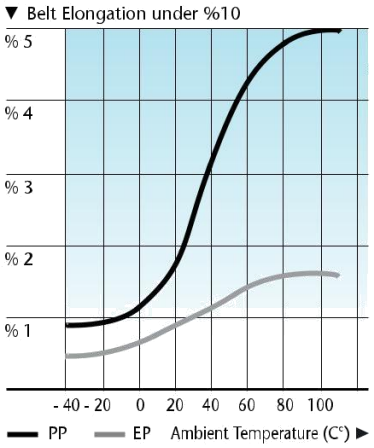


7 x 19

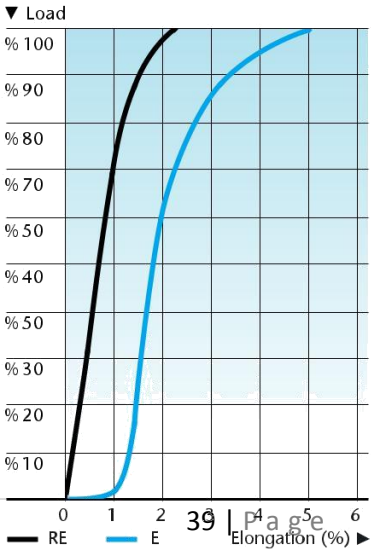
Effect of Elevated Temperature on Belt Strength



Effect of Elevated Temperature on Belt Elongation



Steel Cord Elongation Diagram



TYPES OF CONVEYOR BELTS ACCORDING TO STEEP ANGLE

❶ Conveyor belts with no surfarce partitioning

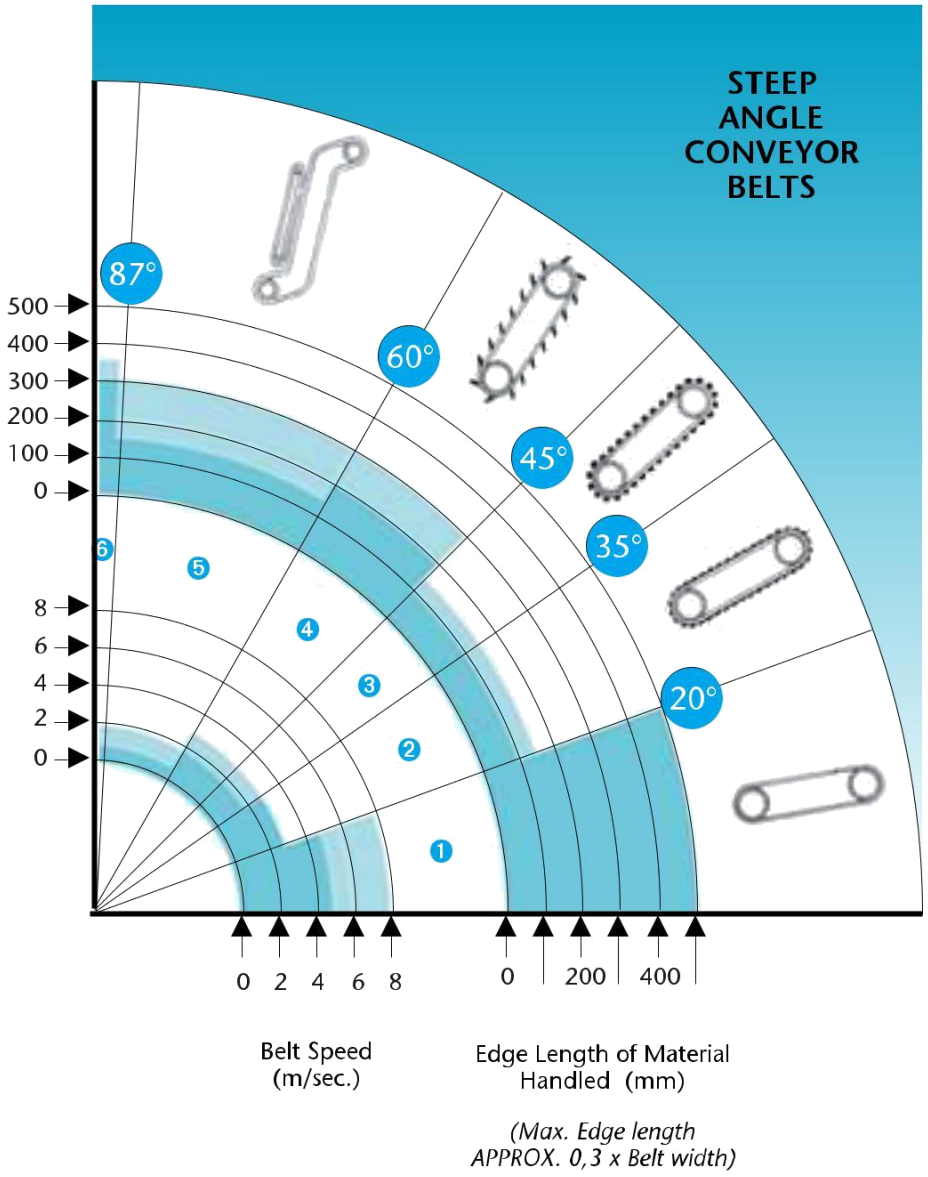
❷ Piece goods conveyor belts with cover patterning

❸ Belts with chevron cleats

❹ Box-section belts with corrugated sidewalls

❺ Conveyor belts in sandwich design

❻ Elevator Belts



TYPE A
ABRASION RESISTANT BELTS

❶ Generally natural rubber based material.
❷ Recommended for conveying large lumps, abrasive material under hard working conditions.
❸ Manufactured in compliance with DIN 22102, TS 547, TS 4464, BS 490, UNI 3718.
❹ Resistant to high impact energy.
❺ Max. 70 °C working temperature.
❻ Elektrostatic conductivity according to TS 547, TS 4464 and DIN 22104 *(Resistance < $3x10^8$ ohm)*
❼ Not recommended for oily, acidic, alcali media but resistant to oxygen, ozone, impacts and abrasion.

Application Places:

Cement works: Quarries, open stroge and reclamation, preblending. **Ports:** Ship loading or unloading installations. **Quarries:** Primary and secondary conveyors. **Public works:** Boring, tunneling, earthmoving. **Steelworks:** İron are handling, open storage and reclamation, sinter plant, blast furnace feed, slag recovery. **Electricity Generating Stations:** Preblending, feed to hoppers, open storage and reclamation. **Sugar mills:** Handling of raw beets. **Pulp mills:** Handling of logs. **Coal Mines:** Tipping, refilling, washing.

SPECIFICATIONS	ÖZERBAND SPEC. S		COMPARATIVE NORMS									
			TS 547 EN ISO 14890			TS 4464	UNI 3718		DIN 22102		BS 490	
Rubber Grade	A*	A+	H	D	L	A	A*	B+	M*	N+	M24*	N17+
Tensile Strength (kg/cm²)	≥ 250	≥ 175	250	180	150	≥ 250	≥ 250	≥ 200	≥ 250	≥ 200	≥ 240	≥ 170
Elongation at Break (%)	≥ 450	≥ 400	450	400	350	≥ 450	≥ 550	≥ 500	≥ 450	≥ 400	≥ 450	≥ 400
Abrasion (mm³)	≤ 150	≤ 200	120	100	200	≤150	–	–	≤150	≤ 200	–	–
Hardness (Shore A)	63±5	63±5	63±5	63±5	63±5	63±5	–	–	–	–	–	

* Recommended for heavy, sharp edged and large lumps (> 100 mm) in difficult working conditions
\+ Recommended for less heavy, rounded, smaller lumps (< 100 mm)

TYPE F
FLAME RESISTANT BELTS

SPECIFICATIONS	ÖZERBAND SPECIFICATIONS	COMPERATIVE NORMS
		TS. 4464 F
Tensile Strength (kg/cm²)	≥ 175	≥ 175
Elongation at Break (%)	≥ 400	≥ 400
Abrasion (mm³)	≤ 225	≤ 225
Hardness (Share A)	63±5	63±5

▲ Central Anatolian Lignite Establishments underground Mine Belt 1200 mm/ST 1000

❶ Chloroprene rubber based, flame resistant covers.
❷ Generally used in underground mine pits.
❸ Manufactured according to TS 4464 ve DIN 22103.
❹ Suitable for difficult working conditions as type A
❺ Max. 100 °C working temperature.
❻ Electrostatic conductivity according to TS 547, TS 4464 and DIN 22104 *(Resistance < 3 x 10^8 ohm)*

Aplication Places:

Underground coal mines

TYPE T
HEAT RESISTANCE BELTS

❶ Generally EPDM based covers.
❷ Used in conveying high temperatured materials
❸ Temperature of the material
100 °C – 400 °C
Belt surface temperature
60 °C – 200 °C
❹ Resistant to acids, oxygen, water and ozone.
❺ Electrostatic conductivity according to TS 547, TS 4464 and DIN 22104 *(Resistance < 3 x 10^8 ohm)*

Application Places:

Foundries: Knock - out sand
Cement Works: Clinker
Steelworks: Hot sinter
Lime Kilins: Kilin discharge
Brickworks.

SPECIFICATIONS	ÖZERBAND SPECIFICATIONS	COMPERATIVE NORMS
		TS. 4464 T
Tensile Strength (kg/cm²)	≥ 150	≥ 130
Elongation at Break (%)	≥ 350	≥ 350
Abrasion (mm³)	≤ 250	≤ 250
Hardness (Shore A)	65±5	70±5

TYPE O
OIL RESISTANT BELTS

SPECIFICATIONS	ÖZERBAND SPECIFICATIONS	COMPERATIVE NORMS
		TS 4464 O
Tensile strength (kg/cm²)	≥ 130	≥ 100
Elongation at break (%)	≥ 300	≥ 300
Abrasion (mm³)	≤ 225	≤ 300
Hardness (Shore A)	65 ± 5	70 ± 5

▲ Oily Fertilizer Belt 650 mm/EP 500

❶ Generally Nitrile based covers.
❷ Resistant to oil and grease and used in conveyors working under these environments.
❸ Max. 90°C working temperature.
❹ Resistant to acids, aliphatic and aromatic hydrocarbons.
❺ Electrostatic conductivity according to TS 547, TS 4464 and DIN 22104 *(Resistance < 3 x 10^8 ohms).*

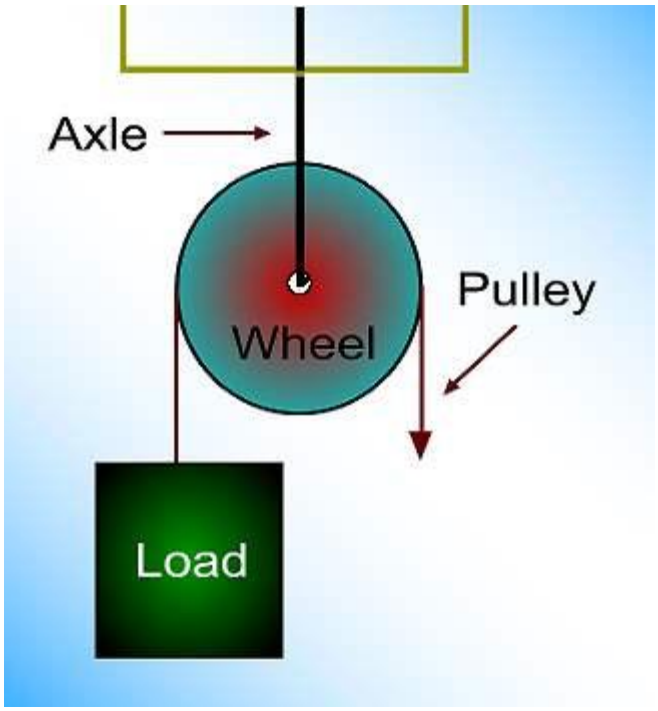
Aplication Places:

Glass works: Oil imprengnated glass waste
Fertilizer plants: Complex treated fertilizers.

2.3.2 Conveyor Components

Pulley

A pulley is just a wheel and axle with a groove around the outside. It uses the principle of applying force over a longer distance, and also the tension in the rope or cable, to reduce the magnitude of the necessary force. Complex systems of pulleys can be used to greatly reduce the force that must be applied initially to move an object. A pulley needs a rope, chain, or belt around the groove to make it do work. Pulleys are used to change the direction of an applied force, transmit rotational motion, or realize a mechanical advantage in either a linear or rotational system of motion.



Types

Like Roller only belt wraps around

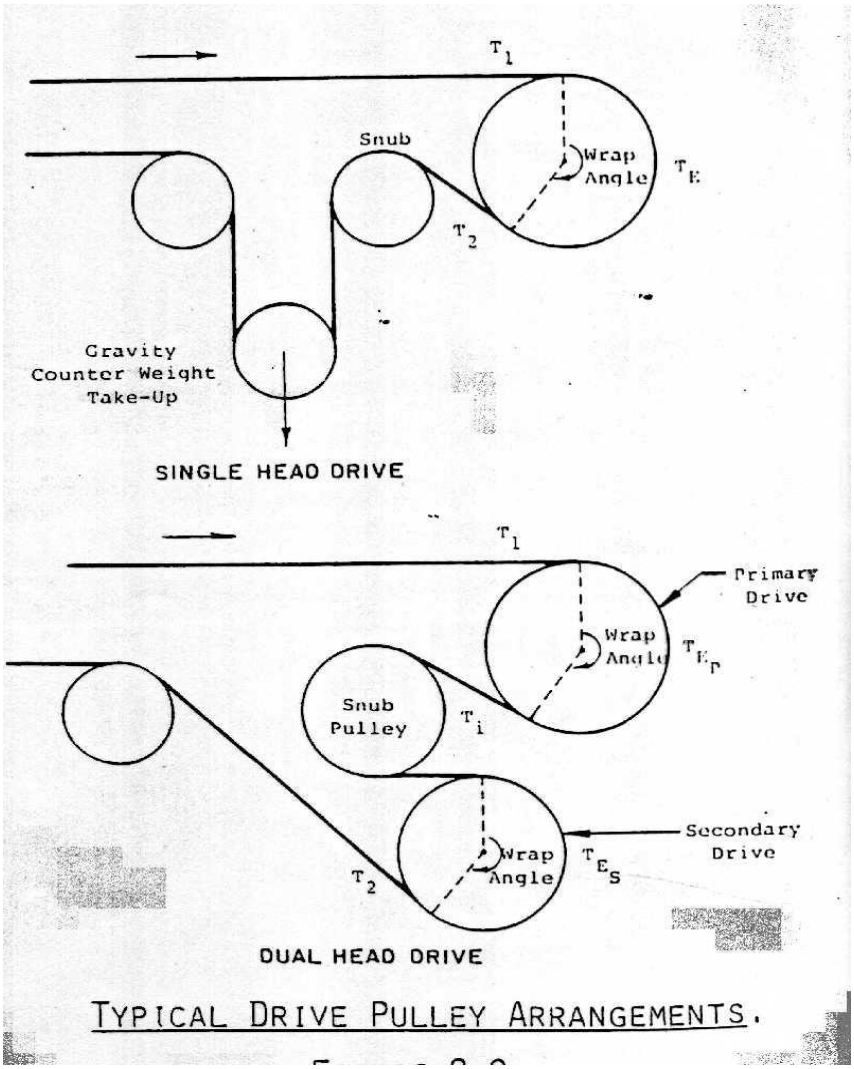
Head Pulley - turns belt back around to return - may be coupled to drive

Tail Pulley - turns empty belt around for loading - occasionally coupled to drive

Drive Pulley - Coupled to motor pulls belt - usually special grip surface

Snub Pulley - usually used to change direction of belt and increase the contact angle with the drive pully (more surface area to transfer power)

Take Up Pulley - Used to maintain tension on a belt left loose enough for some flexibility



Conveyor Belting Parts and Types

Conveyor belts have two basic components: the carcass, or strength member, and the rubber, which protects the carcass.

Most belt carcasses are produced from fabrics that use polyester or nylon fibers, or a combination of the two. These fabrics are completely resistant to the deteriorating effects of moisture, and are resistant to most chemicals. The inherent strength of the fabrics give exceptional resistance to cutting and snagging by abrasive or gritty materials, and retain their strength indefinitely.

The rubber used in conveyor belting, whether natural or synthetic, is compounded to protect the carcass from the material being conveyed, and from any external conditions which could shorten the belt's useful life. The conveyor belt design seeks to ensure comparable service life for both the cover and the carcass, so that they wear out at the same rate, regardless of conditions.

- **Carcass** - woven fabric or material for tensile strength
- **Skims -** rubber layers between carcass plys
- **Braker** - fabric coat above carcass to break impact of load
- **Top Cover -** A rubber that resists cutting abrasion and sometimes chemical action

Types of Carcass

Multi-Ply - multi-ply carcass separated by skims - traditional - trade-off between stiffness and strength

Reduced Ply - complex interwoven carcass not dependent on separate plys thinner less stiff for same strength

Steel - carcass lengthwise steel belts - high tensile strength - heavy ores long runs

Solid Woven - Carcass impregnated with elastomer

Idlers

- Supports Belt and Material Load
- Built with
  - Shaft surrounded by bearings
  - Then roll of steel or rubber
- Two main types
  - Carrying for material and belt
  - return supports belt on return trip

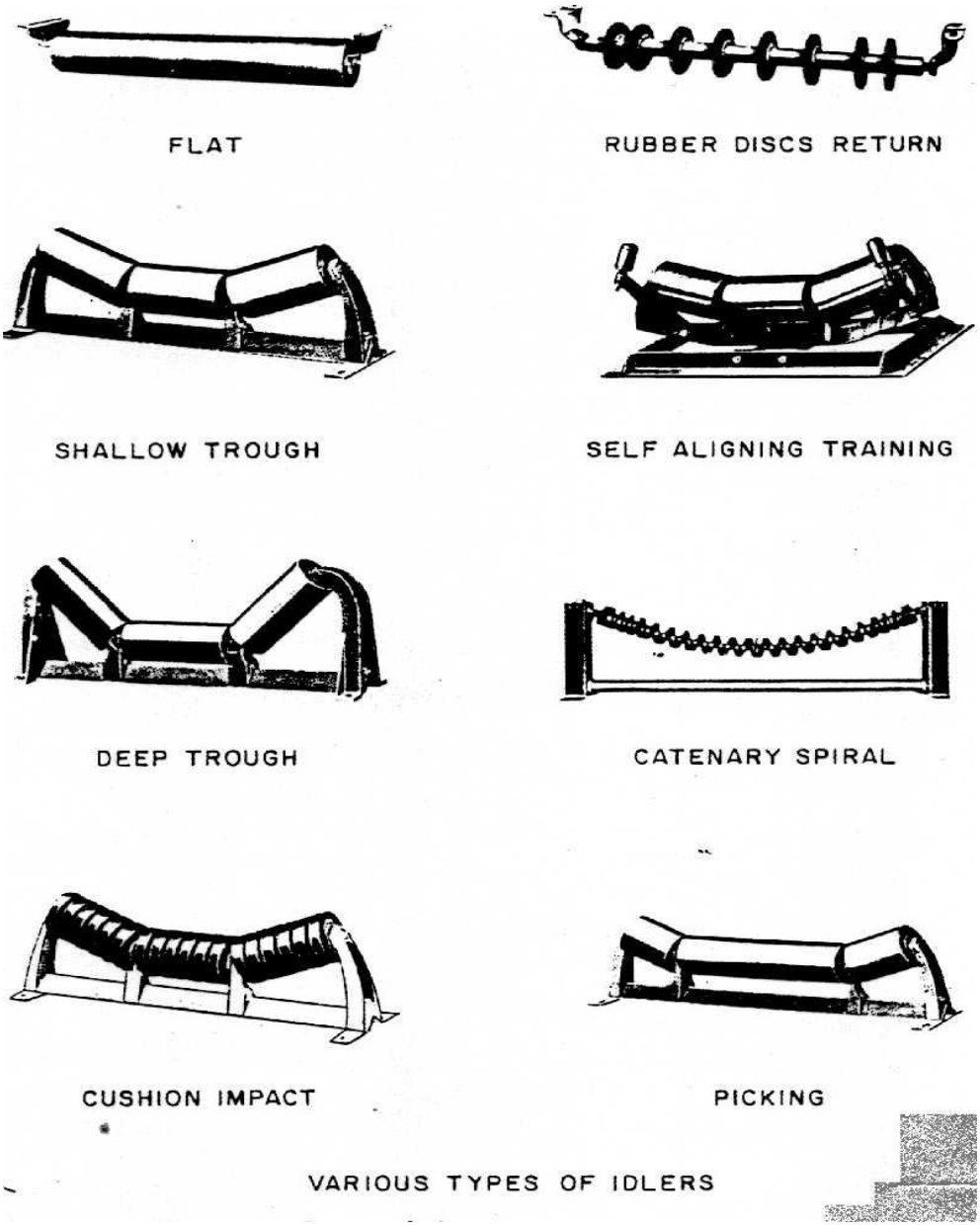
Idlers Size and Duty

- Rated by Diameter
  - ranges 4 to 7 inches

  - smaller is less costly but higher wear and frictional losses
  - 5 inches common for mining
- Rated by Weight Carriage
  - ranges A to E for increasing duty
  - A and B light C and D heavy duty E extra
  - B and C common for mining

Carrying Idlers

- Usually troughed with 3 equal size rollers on a frame in mining applications
  - Some suspended catenary systems have 5 rollers
- Troughs usually 20 , 35, 45 degrees
  - Deeper trough more volume
  - Requires thinner belt to lay in trough which limits strength
  - 35 common choice for mining



VARIOUS TYPES OF IDLERS

Specialty Idlers

- Impact Idlers for taking material dropping onto belt
- Belt Training (Training means keeping in line in trough)
- Can put idler off center to pull to side
- Can put wheels on edge but wear belt
- Can put v return to pull one way or other.

Unit 2.4: Diagnosing the common defects of conveyor belt

Unit Objectives

At the end of this unit, you will be able to:

1. Identification of defects in conveyor belt

4.5.1 Diagnosing tools for defects

A system should be established by management to examine conditions of conveyor belt, whether they are well-constructed and free from defects. If the worn out or damaged parts cannot be repaired, the whole belt should be discarded immediately.

Conveyor belts must be inspected every time before use (as mentioned above). Special care should be paid to the cleanliness and housekeeping.

Defective parts can cause serious and painful injuries.

If a tool is defective in some way, DON'T USE IT.

Diagnose for following problems and be aware of these:

- Excessive top cover wear over entire top surface or in load carrying area.
- Excessive pulley cover wear.
- Excessive edge wear.
- Belt runs off at the head pulley.
- Belt runs off at tail pulley.
- Belt runs to one side for a considerable distance, or the entire conveyor.
- Belt slips when conveyor is started.
- Belt slips while running.
- The covers are hardening and/or cracking.
    - A. Heat or chemical damage to the belt. Make sure to use the correct belt carcass and compounds for the application.
    - B. Compound degradation due to ozone and ultraviolet light during long term storage. Store inside out of direct sunlight and weather. Utilize spare belts sooner.
    - C. It is a natural tendency for rubber to get harder as it ages. This is due to the drying out of the plasticizers in the compound. As belts age, and the rubber dries out, the cover wear will be accelerated. This is similar to what is commonly referred to as dry rot in tires.

- The cover/s are swelling and/or getting soft s in certain areas.
- A certain section of the belt runs to one side regardless of the location on the conveyor.
- The belt runs to one side only in a certain section or portion of the conveyor.
- Vulcanize splice failure.
- The belt is curling up on the edges, cupping. The belt was fine when installed but over time it cupped.
- Belt runs fine when it's empty but wont track right when it's loaded.
- The top cover is grooved, gouged, or the top cover is stripped off.
- Belt breaks just behind the mechanical fastener, or the mechanical fastener pulls out.
- Carcass fatigue at the junction of the individual idlers on a carrying idler set.
- The belt is curling or cupping down, towards the bottom cover.
- The belt is getting narrower.
- The belt is shrinking on a slider bed system.
- The belt is stalling or jerking.

How to diagnose and fix the issue

1. Check for product, debris, and buildup

Inspecting a conveyor for mechanical and cleanliness issues needs to be a part of your standard preventive maintenance. The most prevalent source of mis-tracking is a result of product or basic materials built up on the bottom side of the conveyor belt or pulleys. Often this pending result can create a crown or raised portion on the pulley which can result in the conveyor belt mis-tracking to one side or the other.

2. Check to ensure the conveyor frame is level and square

Product and line changes happen frequently in the baking industry. This usually means current conveyor systems are moved or modified to meet the latest production requirements. It is during this process a conveyor bed may become out of level or square. When a conveyor bed is out of level or square, the conveyor belt has a tendency to move toward one side or the other. This can be checked by utilizing a standard level. Be sure to check both the frame and the pulleys as well.

Making sure your conveyor bed is square is also easy to do. Simply measure dimensions from one corner to the opposite corner on each side of the conveyor. The measurements should equal one another. Don’t worry if you’re slightly out of square, as most manufacturers provide what are referred to as *squaring rods*on the bottom side of the conveyor. These can be used to pull the frame back into alignment.

3. Check to ensure the end pulleys are square

Sometimes, the wrong pulleys are used to track or adjust the belt. This is a common problem when the conveyor utilizes a center drive and tracking configuration. Start by checking to ensure that every pulley is properly aligned with the conveyor frame. Only use snub rollers and idlers to make tracking adjustments. If at all possible, avoid using the drive roller for tracking adjustment.

4. Check to ensure the conveyor belt has been cut straight

Unfortunately, not all belts we receive are cut and shipped perfectly. When a belt is slit incorrectly, this can put an arc or curve into the belt, which will result in a mis-tracking condition. If the belt is not aligned correctly during the joining process (laced or made endless), this too can cause a mis-tracking condition. If you suspect this is the case, remove the conveyor belt from the conveyor, lay it out on a table or floor, and see if you notice an arc or curve in the belt. If it is not straight, the belt needs to be replaced.

Notes

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3. Prepare for belt conveyor maintenance operation

Unit 3.1 – Conveyor Maintenance Checklist

Unit 3.2 – Preventive Maintenance Checklist

Unit 3.3 – Belt Conveyor Inspections

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know the checklists for maintenance of the conveyor belt.
2. Inspect the equipment for scheduled maintenance or defects.
3. Prepare the equipment for carrying out the operation.

Unit 3.1 – Conveyor Maintenance Checklist

Unit Objectives

At the end of this unit, you will be able to:

1. Know about various checklists for maintenance of conveyor belt.
2. Know about general precautions for maintenance.

3.1.1 Various Checklists

Basic Conveyor Maintenance

To obtain the optimum return on conveyor systems, the following components that typically make up a conveyor system must be maintained:

- Drives
- Take-up systems
- Control equipment
- Belting
- Pulleys
- Troughing idlers
- Return idlers
- Tail sections
- Impact-loading equipment
- Chutes
- Skirting
- Belt scrapers
- Equipment guards
- Covers
- Walkways
- Structure
- Transfer stations
- Specialized components associated with site-specific activities

Conveyor Maintenance Checklist

While the system is in operation, check the following issues and refer to all relevant safety warnings and information:

- Regularly walk around both sides of the system and note the condition, as well as any unusual behavior of all the moving components.
- Note points of material buildup.
- Look for any signs of misalignment or improper belt tracking.

- Check drive amperage requirements and compare amperages to previous levels for similar loads and conditions.

'''Note''': A rise in amperage levels above previous levels may be an indication of increased drag within the system, perhaps due to failed or unlubricated bearings. This should be further investigated when the system is at rest and electrically locked out.

Check the following while the system is at rest and electrically locked out:

- Confirm that components are in proper alignment and make necessary adjustments.
- Closely inspect suspect components and take corrective action as appropriate (i.e., if rolls are not revolving freely, relubricate or replace).
- Check all safety systems.
- Test control equipment.
- Check for belt wear — especially at edges and splices — and belt stringing.
- Check for damage or wear at loading and transfer points.
- Check clearances at chute and skirting areas.
- Remove any material buildup on components and clean up any spills along the system.
- '''Note''': The causes of such should be investigated and corrected.
- Relubricate all pillow block bearings per the manufacturer's schedule or the specific requirements of the installation.
- If relubricatable, relubricate troughing and return rolls per the manufacturer's schedule or the specific requirements of the installation.
- Check the condition and functionality of belt scrapers, and adjust or replace as needed.
- Confirm that all guards and covers are in place.
- Replace motor brushes as specified by the manufacturer.

Unit 3.2 – Preventive Maintenance Checklist

Unit Objectives

At the end of this unit, you will be able to:

1. Know about preventive maintenance checklist to be followed.

3.2.1 Preventive Maintenance Checklist

The preventive maintenance procedures listed below provide an easy means of determining the operational status of the conveyor. The preventive maintenance procedures result in identification of possible trouble areas so the condition will not deteriorate to the point where a failure is likely to occur.

The **objectives** of the preventive maintenance checklist are to ensure the equipment is working at maximum efficiency over long periods of time and eliminate costly repairs and downtime.

To ensure effective control over maintenance operations and to permit comparability between equipment as a means of evaluating the maintenance program, preventive maintenance procedures are criteria that may be applied at all equipment locations.

Preventive maintenance can be divided into three categories, each of which is represented by a separate type of checklist.

Inspection Checklists

These checklists specify those activities that call for the highest level of mechanical and electrical skill. These checklists are primarily concerned with inspection and adjustments, though tightening and cleaning activities may be included when delicate or complex equipment is involved. Inspection checklist activities are limited to weekly, monthly, quarterly, semiannually, and annual intervals. During an inspection, never touch a moving belt or rotating part.

Routine Preventive Maintenance Checklists

These checklists are concerned with all of the activities listed above, but are normally directed at a level of skill between that required for inspection checklists and that required for cleaning and lubricating checklists. Inspection and adjustment work assigned at this level is less complex than work listed on inspection checklists. Performance frequencies for routine preventive maintenance checklist activities are, in most cases, limited to daily, weekly, and biweekly intervals.

Daily

Performed by Operator

1. Check operation of conveyor controls. Ensure that all "STOP" pushbuttons operate properly. Also ensure that all limit switches function properly.
2. Clean any accumulation of dust and/or dirt from the conveyor surfaces and remove any accumulation of debris. Do this with the conveyor belt stopped. Never touch a moving belt or rotating part.
3. Ensure belt is tracking properly.

Weekly

- Safety - Observe all safety precautions. Turn off the conveyor except when operations must be performed with equipment running. Never touch a moving belt or rotating part.
- Examine controls and wiring - With the conveyor shut down and disconnected, look for damage to conduit and wiring. Do not touch loose wires.
- Examine Motor and Reducer - With the conveyor shutdown, look for damage to motor and reducer housings. Look for evidence of lubricant leakage from gear case. If leakage is detected, check for proper oil level. Add oil if required.
- Clean Conveyor - Remove any accumulated debris from beneath the surfaces of the conveyor. Make sure the conveyor is locked out.

- Clean Up - Restore conveyor to its original status. Ensure all inspection equipment is removed from work area. Initiate repair work orders as required. Report serious deficiencies to the maintenance supervisor.

Monthly

Examine pulleys and bearings - With the conveyor running, listen for abnormal noise coming from any pulley assembly or bearing. All pulley bearings should be lubricated every four to six weeks. Tighten setscrews as needed. Never touch a rotating part. Use a metal rod to transmit sound to your ear and note any excessive bearing noise. Never reach under or into the conveyor when the belt is running. For access to some pulleys, covers must be removed in mating boom sections. Use a metal rod to reach through access windows to contact bearings. See assembly drawings for locations.

Examine Belt - With the conveyor running, look for damage to belt or belt lacing. Remove any raveled edges or cord that might catch on pulley assemblies. Also repair or replace belt lacing that shows physical damage. Never perform any work on the belt while it is moving.

Return Rollers - Using a metal rod, contact the protruding ends of the hex shafts to listen for abnormal bearing noise. Remove window covers to gain access to some roller shafts. Never reach your hand through these windows when the belt is running. Replace all covers when done. Never reach under the machine when the belt is running.

Examine Mounting Bolts - Check all drive motors by jogging units to ensure mounting bolts are tight. Check conveyor hold-down bolts to ensure the conveyor will not come loose from floor hold-down devices.

Electrical Cable Reel - Inspect the electrical cable to ensure that cable is not pulling out from a cable connector. Also completely extend and retract the conveyor, observing the recoil of the cable. If the cable is sagging, completely extend the conveyor and attempt to add an additional wrap to the spring at the reel housing. Do not over-tension the spring by over-wrapping the cable. See manufacturer's literature.

Electrical Wiring - Check all electrical conduits and fittings to ensure damage has not been done to the system. Fix damaged, loose, or bare wiring or connections.

Clean Up - Restore the conveyor to its original status. Ensure all inspection equipment is removed from the work area. Initiate repair work orders as required. Report serious deficiencies to the maintenance supervisor.

Quarterly

Cam Roller Lubrication and Adjustment - Inspect and adjust cam rollers. Both front and rear cam support blocks have provisions for lubrication. Front blocks can be lubricated without guard removal. To lubricate rear cams, the rear guard must be removed. All cam rollers should be checked for proper adjustment (see boom alignment instructions). The machine should be locked out for this procedure.

Semiannually

1. Change fluid in gear boxes - Twice a year the gear head lubricant should be changed. The gear cases should be drained and cleaned. When adding oil to any gear box, use the following procedure: a. Remove the oil level plug in the side of the box that controls the oil level height. b. Remove the fill line plug located on the top of the gear box. c. Add lubrication through the top fill line port. d. Add lubricant until it runs out of the fluid level line hole. '''Caution: Do not over-fill gear box with oil.''' e. Replace both plugs in gear box. '''Electrical lockout is required.'''

2. Examine master control panel - Wipe dust from exterior of panel. Open panel door. Remove dust from the interior of the panel. '''Do not touch wires.''' Look for burned wiring and loose terminal connections. Close panel.

3. Observe drive section - With the conveyor running, carefully contact motor and reducer housing with metal rod to detect excessive vibration from bearings or gears. Listen for evidence of wear or damage to internal parts. Do not go near moving parts.

4. Clean boom roller chains - With the conveyor shut down and locked out, wipe dirt from chains and sprockets. Lubricate chain with SAE #10 weight oil.

5. Wheel bearing inspection and lubrication - If the conveyor is a traversing unit, each wheel bearing should be inspected for wear, proper alignment, and tightness in the wheel mount. All wheel bearings should be lubricated at least twice a year, and quarterly if unit is traversed regularly. '''Lock-out is required. '''

6. Track clean out - If the unit is of the traversing type with a floor mounted track, the rear track should be checked for build-up of dirt and debris. This should not be allowed to build up where it interferes with conveyor wheels. Clean-out slots are provided at each end of the track for removal of debris.

Preventive Maintenance - Limited Use

It is recognized that conveyors may be installed in locations not staffed to carry out the complete maintenance program. Where qualified personnel are not available, the preventive maintenance program should be limited to performing the cleaning and lubricating and routine preventive maintenance routes only. The inspection routines can be assigned to the operator.

'''Note''': Preventive maintenance instructions and checklists should be followed.

Lubrication

Lubrication points on the conveyor are confined to:

Pillow block, take-up, and flange bearings holding the main pulley assemblies.

Cam rollers and cam followers for guiding and supporting the booms as they extend and retract.

Each bearing has its own grease fitting and is accessible from either the front, rear, or each side of the conveyor section. In order to lubricate the rear cam rolls and followers, the rear cover of the machine must be removed. All greasable joints have standard grease fittings and can be reached from one of the above locations.

Unit 3.3 – Belt Conveyor Inspections

Unit Objectives

At the end of this unit, you will be able to:

1. Know about inspections to be done for maintenance of equipment.

3.3.1 Inspections Checklist

Belt Conveyor Inspections

- An inspection system must provide for the carrying out of periodic inspections of each operating belt conveyor in the plant.
- Belt conveyor inspections must include inspections of the following:
- Belt conveyor alignment and clearance
- Accumulations of spillage, dirt, and debris
- Condition of belt conveyor structure, including idlers and return rollers
- Evidence of overheating of the driving head, idlers and rollers
- Undue accumulations of lubricant
- The condition of the conveyor belt, including joints
- The condition of scrapers and sprays
- Any evidence of heating or ignitions
- The effectiveness of the guards of the boot ends, transfer points, and drive heads
- The condition of the remote control or signaling system

4. Carry out the assigned job for belt conveyor maintenance operation

Unit 4.1 – Conducting Preventive Maintenance

Key Learning Outcomes

At the end of this module, you will be able to:

1. Conduct Routine maintenance or rectify the problem, as appropriate.
2. Conduct tests to ensure fitness.
3. Know about the work completion.

Unit 4.1 – Troubleshooting

Unit Objectives

At the end of this unit, you will be able to:

1. Know about the problems and their solutions.

4.1.1 Troubleshooting

Problem: Excessive top cover wear over entire top surface or in load carrying area.
Solution:

A. The top cover quality is not adequate for the system/material being conveyed. Upgrade to a heavier top cover. Upgrade to a better cover compound.
B. Off centre loading or improper loading of the belt. Make sure load chute places the load in the centre of the belt. Make sure the direction of the material down the chute is in the direction of the belt travel.
C. Material build-up on the pulley faces of the return idlers, or on the conveyor structure it's self. Clean system, improve material containment, install cleaners, check skirting, install belt scrapers after the head pulley.
D. Frozen, dirty, or misaligned return idlers. Clean rollers, properly align rollers, install cleaning devices at head pulley, use self cleaning rollers, improve maintenance (alignment, lubrication, and cleaning).
E. Too much distance in between the idlers causing excessive material movement as the load travels up and over the idlers. Decrease the distance between idlers, increase tension if the belt is under tensioned.

Problem: Excessive pulley covers wear.
Solution:

A. Frozen idlers. Replace or repair frozen idlers. Improve maintenance of idlers (lubrication, cleaning, alignment).
B. Insufficient traction between belt and drive pulley. Make sure drive pulley is free of build up. Lag Drive pulley. Increase belt wrap on drive pulley. Increase belt tension if the belt is under tensioned.
C. Material build-up on the pulley face or conveyor structure. Clean system, improve material containment, install cleaners, check skirting, install belt scrapers in front of pulleys.
D. Material is getting trapped between belt and pulleys. Improve containment at load point. Improve containment along the conveyor. Install ploughs or scrapers in front of tail pulley. Practice good house keeping.
E. Bolt heads from pulley lagging, or from slider bed material hold down on bare backs, are sticking up and catching the belt. Inspect and replace or tighten as required.
F. A condition of tilted or over tilted troughing idlers exists. Idler frames should be located per manufacturer's recommendations, usually at 90 degrees to the belt and conveyor frame. Align idlers per manufacturer's recommendations.

Problem: Drive pulley turning, but belt is not
Solution:

- Part caught in belt - (remove parts)
- Lagging on pulley, if equipped, worn out – (replace lagging)
- Belt too loose – (tighten belt)
- Side rails bent down on belt – (straighten side rails)
- Cleats, if equipped, rubbing on side rails – (adjust side rails out)
- Water or oil between belt and slide bed creating a suction - (clean slide bed and back of belt)

Problem: Motor running but drive pulley not turning
Solution:

- Key in shaft of motor missing – (replace key)
- Internal gears in reducer broken – (rebuild or replace reducer)
- Shaft on drive pulley broken – (replace drive pulley)

Problem: Idler roller not turning when belt is running
Solution:

(Bushing Style)

- Dirt in idler roller – (remove shaft, clean and lubricate)
- Idler roller or shaft bent – (replace shaft or roller)
- Bushings in idler roller bad - (replace bushings)

(Ball Bearing Style)

- Bearing worn out (replace idler roller)
- Idler roller bent – (replace idler roller)

Problem: Motor won't run
Solution:

- Switch off – (turn switch on)
- Thermal overload tripped – (reset and turn on)
- Supply power disconnected – (reconnect power)
- Bad motor – (replace motor)
- Bad wiring – (check wires and connections

Problem: Conveyor runs for awhile and then stops (Thermal Protection tripping due to overload)
Solution:

- Heater in switch too small for motor – (check heater and replace if the wrong size)

- Motor pulling too much current – (remove overload, such as excessive belt drag or tension. Remove anything that might be caught in the belt)
- Motor going bad – (replace motor)

<u>Problem</u>: Conveyor belt running off to the side
Solution:

- Belt needs tracked – (re-track belt)
- Vee-guide, if equipped, wearing or coming off – (replace belt)
- Not enough belt tension – (increase tension slightly and re-track belt)

SL-18 FINGER SEPARATOR

Maintenance & Troubleshooting

Gearmotor:

The standard SL-18 finger separator comes equipped with a gear motor (motor and gear reducer made as one unit). It is lubricated at the factory while being assembled, and should need no lubrication as long as it is properly mounted with the breather hole UP. The standard AC gear motor supplied on the 40 FPM and the 60 FPM units have an on/ off switch with thermal protection supplied. The DC gear motor supplied on the 100 FPM variable speed unit comes with a DC controller. All power supply is to be 115/60/1 voltage with suitable earth ground.

Bearings:

All bearings are sealed and assembled in the pulleys as they are being manufactured. The bearings will need no lubrication.

Chain and Sprockets:

A. Lubrication: SAE 30 to 40 weight oil should be applied periodically with a brush or spout can. Volume and frequency should be sufficient to prevent discoloration of lubrication in chain joints.

B. Tension and Alignment: Periodically check sprocket alignment and readjust if required. As the chain wears, chain tension will have to be readjusted. The chain sag in the center should be approximately 2% of the centre distance. For a 12” centre, the distance the chain should sag is about ¼”. The sag should be maintained to get optimum life oooout of the chain and sprockets.

5. Activities specific to belt conveyor maintenance

Unit 5.1 – Perform maintenance activities

Unit 5.1 – Conducting Preventive Maintenance Activities

Unit Objectives

At the end of this unit, you will be able to:

1. Perform the maintenance of conveyor belt.

5.1.1 Preventive Maintenance of Conveyor Belt

Observe Conveyor Belt

Observe the condition of the belt, look for excessive wear on the top and sides of the belt. Make sure there are no parts (particularly non-moving parts) that are causing the belt to wear. Check the condition of the lacing and remove any broken staples. Excessive staple breaks often indicate too much belt tension. Use caution when removing broken staples, as they may be sharp.

Cleaning

To clean belt surfaces, use a mild cleaning solution.

Note: Before applying any solution to the belt, check to be sure that it does not affect the material of the belt by trying it on a small area first.

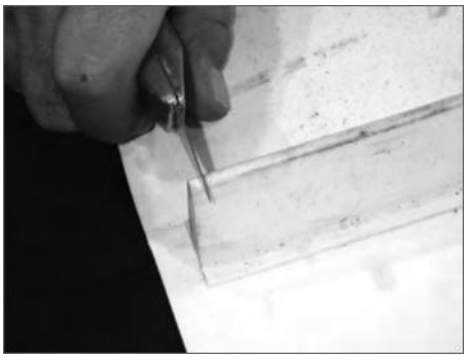
The running conditions of the conveyor will determine how often you should remove the belt to clean the slide beds, and the back of the belt. If oil, water, or other foreign matter gets between the belt and the slide bed, it should be cleaned off immediately. Any kind of liquid under the belt will create suction and will cause more stress to be put on the drive components, such as the motor and reducer. This will diminish the life of the components. While cleaning and inspecting the belt, it is also a good time to check for cleat damage, (if equipped with cleats).

Conveyor Belt Maintenance

If the belt has been removed for cleaning, (Fig. at top), inspect the vee-guide (if so equipped) for excessive wear, and to insure that it is not coming loose from the belt. If the vee-guide is showing excessive wear, it is a good indication that the belt is not tracked properly. If the vee-guide is coming off the belt, (Fig. in middle), a new belt is recommended. If cleats are breaking or tearing loose, check to make sure they are not rubbing on the side rails or catching on any part of the conveyor.

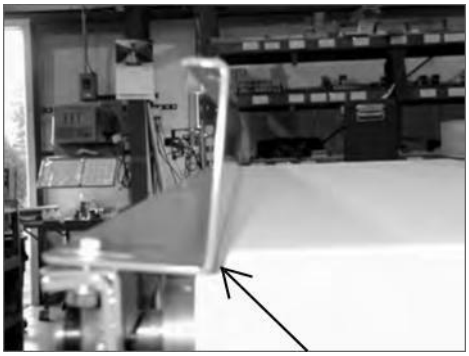
If cleats are rubbing on the side rails, there are three different ways to remedy the problem.

Make sure the belt is properly tracked.

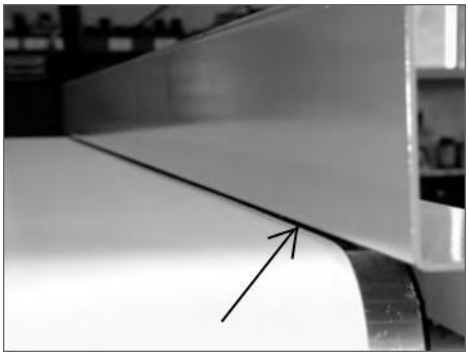


If belt is properly tracked and cleats are still rubbing the side rails, the rails can be adjusted out away from the cleats.
When belts are replaced in the field on a Model KK, KKI, DDK, ADK, or TLK conveyor, the cleats may have to be trimmed back if factory settings for the rails have been changed. (Fig. at bottom)

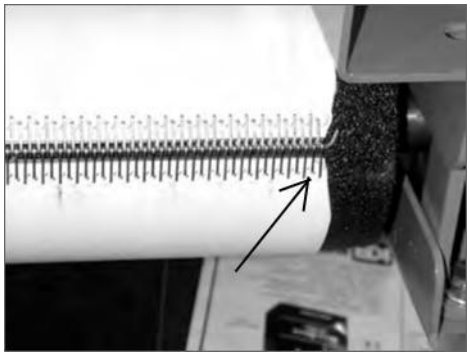
Conveyor Belt Maintenance



Maintain space between the bottom of the side rails and the top of the belt. If the side rails get bent down onto the belt, they will cause undue stress on the drive components. (Fig. at top)



Be sure the belt slides under the side rails freely (Fig. in middle). Rails can get bent down onto the belt from people stepping on them, or sitting something heavy on them. If a side rail should happen to get bent down against the belt, you should be able to bend the rail back up off of the belt.



Check the outside portion of the lacing on both edges of the belt for wear. If the side rail is bent down, the lacing will start to show wear. (bottom figure)

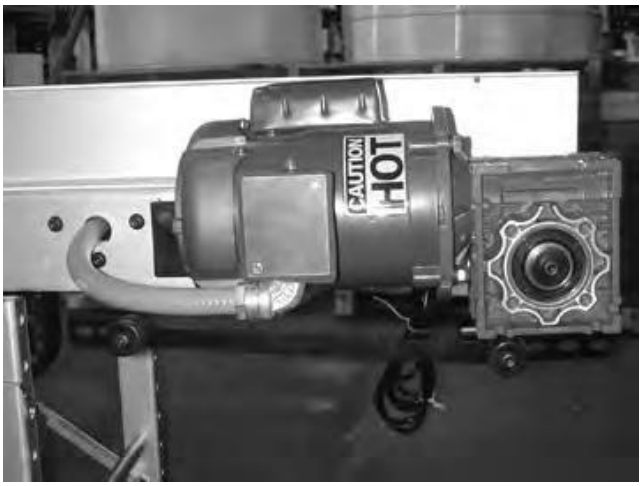
Bearing Removal - RM Conveyor

The take-up bearings are self-aligning, prelu-bricated, ball bearing type. Lubrication is only required approximately every 10 weeks under 24-hour-a-day operation. They should be lubri-cated with #2 consistency lithium-base grease (or compatible) that is suitable for ball bearing service. Grease should be added slowly and in small amounts so as not to damage the shields on the bearings. (Fig. at top) If the shield should get damaged from over-greasing, dirt can enter the bearing, thus greatly reducing the life of the bearing.

Bearing Replacement

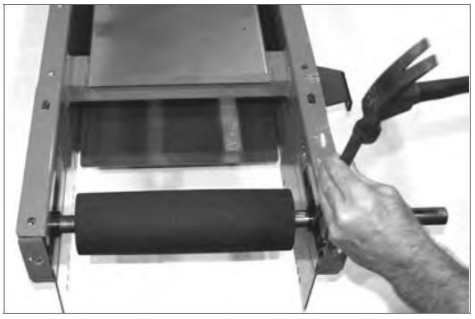
If a bearing should fail and a replacement needed, first (if possible) run the conveyor and stop it so the lacing is on the pulley that needs to come out. (Fig. in middle)

First, make sure power is disconnected from the conveyor. Remove all guards from the reducer (if so equipped). Loosen set screws in collars on both sides of the reducer (if so equipped). Or, remove the bolt from the end of the pulley shaft. Disconnect conduit and wires from the motor. Disconnect reaction rod from the bottom of the reducer. (Fig. at bottom) Slide the reducer and motor off the shaft. Now the pulley is ready to be removed from the frame.



Bearing Removal - RM Conveyor (contd)

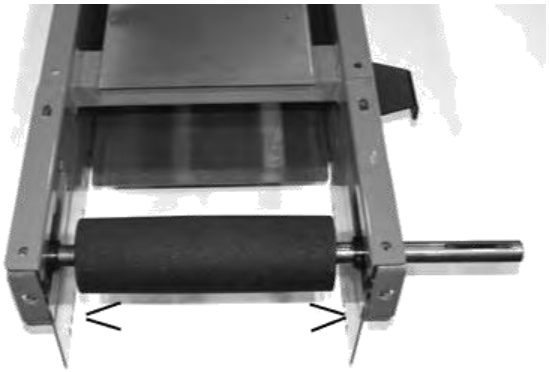
Remove the end take-up brackets. Remove the collars on both bearings by loosening the setscrew and tapping the collar with a punch and hammer in the hole provided. Tap the collar in the direction opposite to normal shaft rotation. Now remove the back-locking nut on both bear-ings and slide the pulley out.



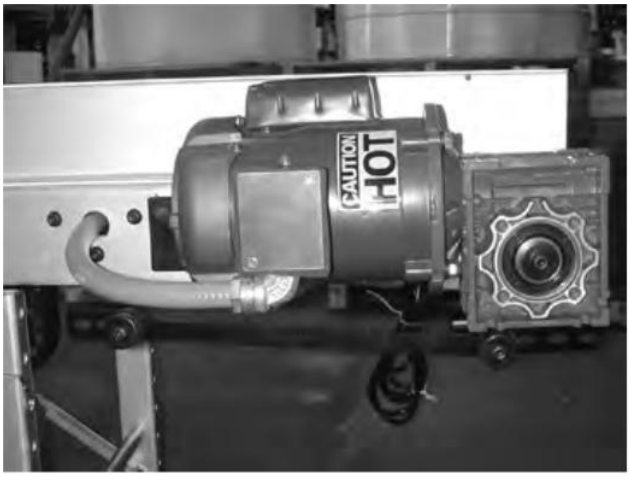
Use extreme care when removing the pulley from the frame as some pulleys can be very heavy, especially wide vee-guided pulleys.

Put the pulley on a work bench and pull the bearing off the shaft. Inspect the shaft for any damage. In some cases if there is too much ten-sion on the belt, the bearing will lock up and the shaft will start turning in the bearing. Eventually, the shaft will wear completely through. If the shaft shows any wear, it is recommended that you replace the pulley.

When installing a bearing, reverse the procedures for removal listed above. Make sure the pulley is centered in the frame before installing collars. Tap the collars in the direction of shaft rotation. Make sure all bolts, nut and setscrews are tight.

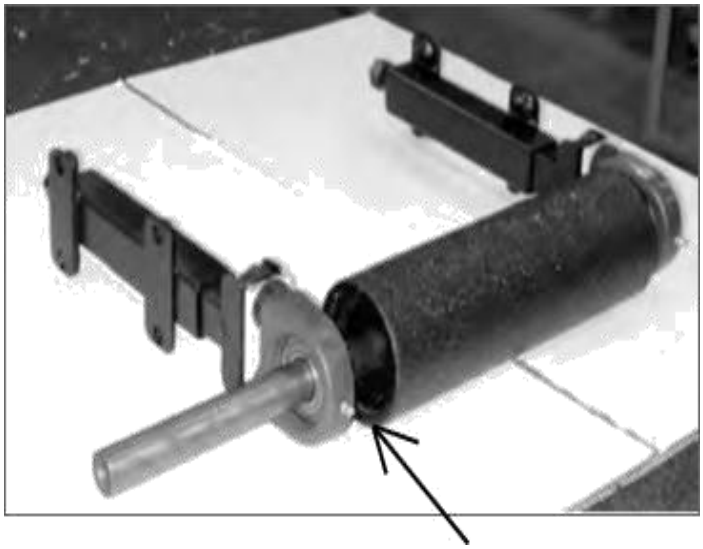


Bearing Removal - ADK & DDK Conveyors



The reducer will have to be removed from the shaft of the drive pulley before the bearing can be changed.

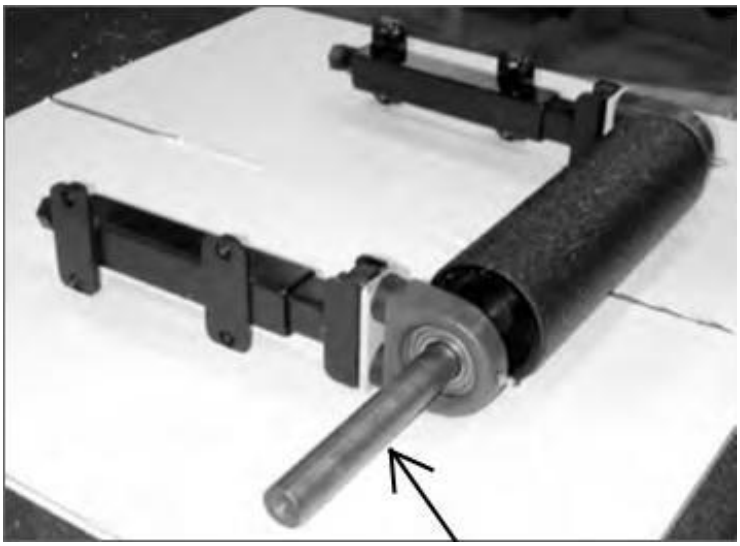
First, make sure power is disconnected from the conveyor. Remove all guards from the reducer (if so equipped). Loosen set screws in collars on both sides of the reducer (if so equipped). Or, remove the bolt from the end of the pulley shaft. Disconnect conduit and wires from the motor. Disconnect reaction rod from the bottom of the reducer. Slide the reducer and motor off the shaft. Now the pulley is ready to be removed from the frame.



Remove the end guards from the frame. Next, remove the four bolts from each side that holds the bearing brackets to the frame (Fig. in middle). After all bolts are removed, slide the pulley out of the frame. Remove the collars on both bearings by loosening the set screw and tapping the collar with a punch and hammer in the hole provided. (Fig. at bottom) Tap the collar in the direction opposite to normal shaft rotation.

Slide bearings off the shaft and inspect it for any wear. (Fig. at top)

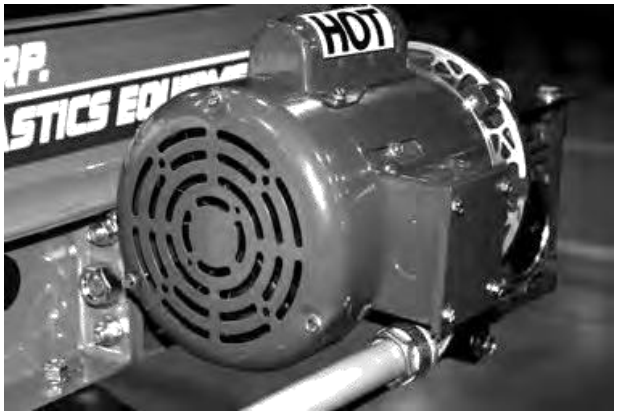
If the shaft shows any wear as far as grooves being worn in the shaft from turning in the bearing, it is recommended that you replace the pulley.

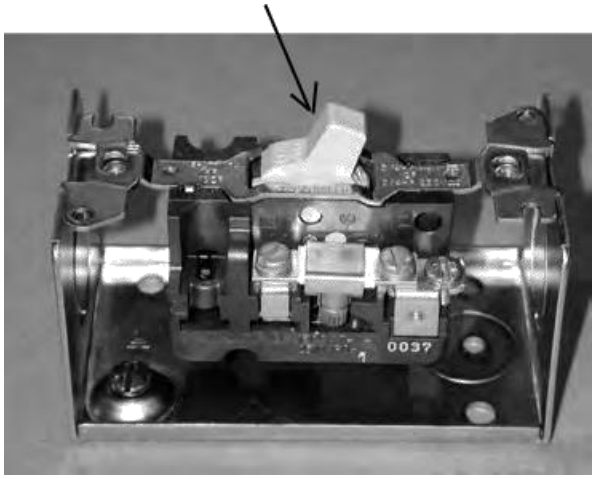


Remove the two bolts that hold the bearing to the bracket. (Fig. at bottom) Bolt the new bearing to the bracket and install back onto the pulley. Make sure the pulley is centered in the frame before the collars are locked on the shaft of the pulley.

Motor Maintenance

The standard motor is TEFC (Totally Enclosed Fan Cooled). The TEFC motor must have all dust and dirt blown out of the fan periodically to prevent poor air circulation. (Fig. at top)



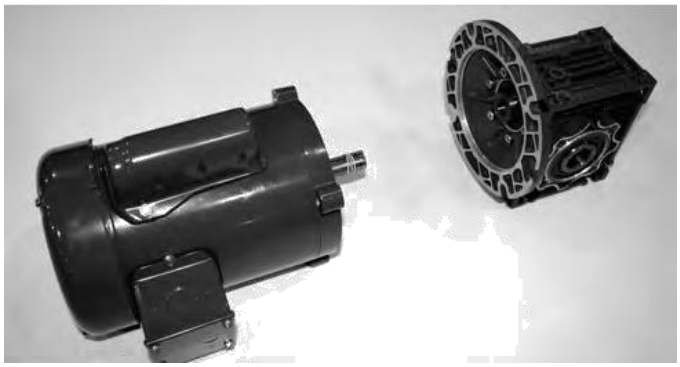


Good air circulation around all motors is required to prevent overheating. The motor uses Class B insulation. Temperature will not affect the life of the motor as long as the electrical current to the motor does not exceed the nameplate rating. This is a standard industrial-use motor. The motor is protected with a current-sensitive heater in the motor starter that shuts the conveyor off if the motor becomes too hot.

Motor Installation

Instructions for Flanged Models

Assemble the key to the motor shaft and coat the shaft with anti-seize com pound. Insert the motor shaft into the reducer input shaft.



Rotate the motor to proper position and firmly secure to flange with four hex-head cap screws.

6. Occupational, Health and Safety (OHAS)

Unit 6.1 - Learn Occupational health & Safety

Unit 6.2 - What is hazard

Unit 6.3 – Safe working practices

Unit 6.4 - Working at Heights and confined spaces

Unit 6.5 – Fire prevention

Unit 6.6 - Emergencies, rescue and first aid procedures

Key Learning Outcomes

At the end of this module, you will be able to:

4. Know about safety requirements, procedures, and resources for different areas
5. Know about safe work practices
6. Know about hazards, types of hazards and how to control hazards
7. Know about PPE requirements
8. Know about safe working practices at heights
9. Know about safe working practices at confined spaces
10. Know about protection from fire hazards
11. Know about fire extinguisher and how to use it.
12. Know about first aid procedures

Unit 6.1: Learn occupational health and safety

Unit Objectives

At the end of this unit, you will be able to:

2. Know about health and safety requirements in industry
3. Know about essential elements for safety
4. Know about good safety work practices

6.1.1 Safety in Steel plant

The health, safety and protection of employees, equipment and the environment are of serious concern in a steel plant since steel plant is an industry of hazardous nature. The health and safety of employees is crucial since it affects both economic and social factors. It is necessary that steel plant management recognizes the advantages of safe work environments and progressively adopt safety management practices to prevent hazardous events, avoid production and manpower losses and fall outs associated with the accidents.

The nature of various types of accidents is shown by an iceberg of incidents (Fig 1). They are unsafe actions, incidents, minor injuries, lost time injuries, serious accidents and fatalities.

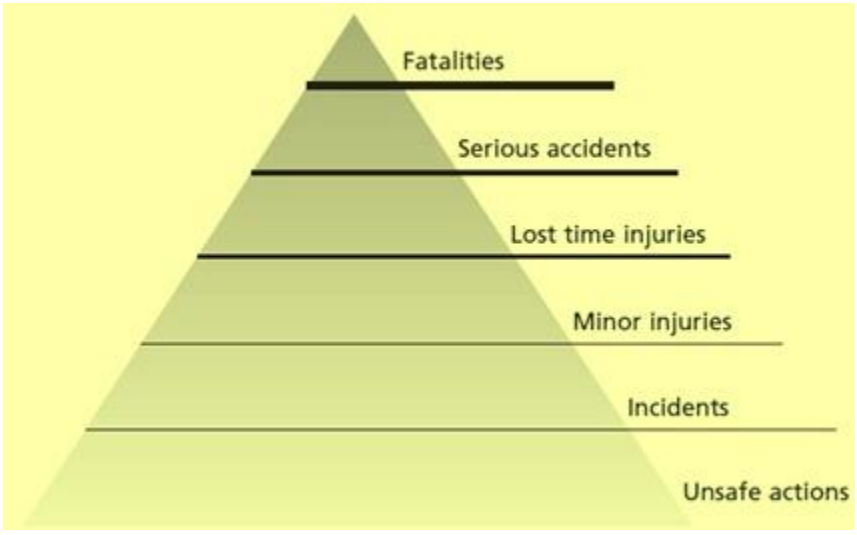


Fig 1 The iceberg of accidents

Every steel plant should aim at zero accident. To aim for an accident free working environment in a steel plant is every one's responsibility. It is possible to reduce dramatically the number of accidents at work

by assigning necessary priority to the safety since a safe way of working is a quality and efficient way of working. The pyramid of the overall of zero accidents is depicted in Fig.2.

Fig 2 The pyramid of overall goal of zero accident

The following three aspects are important for progress of safety in a steel plant.

- The condition of the work place environment e.g. means of access, physical plant safety, housekeeping, and safe place of work etc.
- The training and competence of the employees which include ability to understand apply and respond to safe systems of work.
- The development of motivational and behavioral influences of employees. This includes the use of more direct strategies to identify unsafe behavior and attitudes and to motivate employees.

6.1.2 Essential elements necessary for safety

The following are the essential elements which are necessary for implementation of safety culture in a steel plant.

- Safety consciousness is to be ingrained amongst the workforce as well as among the top management of the steel plant.
- There is to be a communication plan and a participatory way of working from the maximum number of employees which will confirm that the commitment towards the safety is real.
- There is to be recognition of best practices in safety and there should exchange of the safety related ideas both within and between the departments.

- There is to be an appropriate safety organization structure, which is well defined by the management and well understood by everyone. The safety organization is to have well defined role and responsibilities.
- Management should put into place mechanisms which have influence on behavior of the employees towards safety. For example that the safety performance of the employee is to be recognized towards career development.
- Through training programs, management should demonstrate that attitude and behavior to safety is an essential part of the professionalism of every employee and everyone should accept his responsibility not only for his own safety but also for his fellow employees. After all, employees work in steel plant not as individuals but as a part of a team.
- There is elimination of a two tier approach to safety. Contract workers working in steel plant should attain the same level of safety consciousness as the steel plant's own employees and use the same methods to achieve this.

6.1.3 Good safety practices

Good safety practices include the following:

- Assigning and publishing the responsibility and duties of the employees associated with the management of the safety in the steel plant.
- Investigation of all the accidents whether small or big and the implementation of corrective measures.
- Studying the significant safety incidents which have happened in other steel plants and learning from the same.
- Registration and control of safety standards and maintaining a register of the significant incidents.
- Internal and external publication of safety investigation results and the obtained experiences.
- Conducting regular shop review meetings regarding status of safety in the shop as well as monthly review meeting at the chief executive level.
- Conducting training as well as refresher safety training programs amongst the employees where investigation of various incidents are also to be discussed.
- Conducting emergency safety drills.
- Conducting of regular safety audits to locate unsafe areas and practices and to ensure that the corrective actions have been taken. Safety audits can also help in early detection of the equipment deterioration and the deviations and/or procedures that can degrade or deteriorate then safety levels.

Unit 6.2: What is hazard

Unit Objectives

At the end of this unit, you will be able to:

1. Know about hazards and different types of hazards
2. Know about, how to identify and control hazards
3. Know about safe working practices

6.2.1 Hazard

A **hazard** is something that has the potential to cause injury, disease or death in a workplace. A slippery floor could result in someone falling and breaking an ankle.

There are a number of aspects to the development of a safe workplace environment:

- the development of policies
- the development of consultative processes
- Hazard identification, assessment and control.

Implications from hazards/risks can be accessed through:

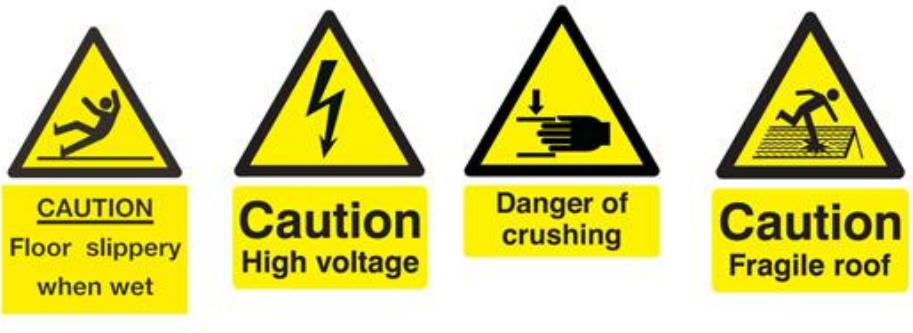
- accident/injury reports
- information on risk from chemicals from data sheets
- review of accident/injury statistics
- information from government health and safety agencies
- specific monitoring
- Who is exposed, how much, how might they be affected.

6.2.2 Types of Hazard

Physical hazards

During the coal unloading, preparation and handling operations, thousands of tones of coal are manipulated, producing dust, noise and vibrations. The presence of large quantities of accumulated dust can produce an explosion hazard in addition to the inhalation hazard.

- During coking, ambient and radiant heat are the major physical concerns, particularly on the topside of the batteries, where the majority of the workers are deployed.
- Noise may be a problem in mobile equipment, primarily from drive mechanism and vibrating components that are not adequately maintained.
- Ionizing radiation and/or laser producing devices may be used for mobile equipment alignment purposes.



Chemical hazards

Mineral oil is typically used for operation purposes for bulk density control and dust suppression. Materials may be applied to the coal prior to being taken to the coal bunker to minimize the accumulation and to facilitate the disposal of hazardous waste from the by-products operations.

- The major health concern associated with coking operations is emissions from the ovens during charging of the coal, coking and pushing of the coke. The emissions contain numerous polycyclic aromatic hydrocarbons (PAHs), some of which are carcinogenic.
- Materials utilized for sealing leaks in lids and doors may also be a concern during mixing and when lids and doors are removed.
- Asbestos and refracting ceramic filters may also be present in the form of insulating materials and gaskets, although suitable replacements have been used for products that previously contained asbestos.

Mechanical hazards

The coal-production hazards associated with railroad car, marine barge and vehicular traffic as well as conveyor belt movement must be recognized. The majority of accidents occur when workers are struck by, caught between, fall from, are entrained and entrapped in, or fail to lockout such equipment (including electrically).

- The mechanical hazards of greatest concern are associated with the mobile equipment on the pusher side, coke side and the larry car on top of the battery. This equipment is in operation practically the entire work period and little space is provided between it and the operations. Caught-between and struck-by accidents associated with mobile rail-type equipment account for the highest number of fatal coke-oven production incidents.
- Skin surface burns from hot materials and surfaces and eye irritation from dust particles are responsible for more numerous, less severe occurrences.

Electrical hazards

The main hazards of working with electricity are:

- electric shock and burns from contact with live parts
- injury from exposure to arcing, fire from faulty electrical equipment or installations
- explosion caused by unsuitable electrical apparatus

Working on or near electrical hazards is dangerous and can be fatal. Any work on or near energized equipment must be done only when measures are in place to provide protection from electric shock and burn. With adequate safety measures in place, every electrical injury and fatality can be prevented.

6.2.3 Hazards in steel plant

A steel plant is full of hazards at every step of its operation. These hazards are to be tackled for the sake of safety in the steel plant. Major amongst these hazards are enumerated below.

- Road hazards – Road hazards are high because of heavy concentration and heterogeneous nature of the road traffic. This hazard is having maximum intensity during the shift change timings.
- Coke oven and byproduct plant – Here the main hazards are heat, dust, smoke, moving equipment, chemicals, fire and explosion etc.
- Sinter plant – In sinter plant main hazard are moving equipment, dust and smoke etc.
- Blast furnace – The main hazards at blast furnace are heat, dust, noise, liquid metal and slag, gas poisoning, moving equipments, moving locomotives, fire and explosion and working at heights etc.
- Steel melting shop – The main hazard in this shop are heat, dust, noise, liquid metal and slag, moving equipment, suspended loads, working at heights and fire and explosion etc.
- Rolling mills – The main hazards at rolling mills are heat, noise, moving equipment, splinters, cobbles, suspended loads and slippery floors etc.
- Power plant – The main hazards are heat, working at height, noise, vibrations and gas and steam lines etc.
- Material handling – The main hazards are posture, excess loads, moving equipment, improper signaling and suspended overhead loads etc.
- Other major hazards which are common to most of the places are working in confined space, working with improper tools, poor illumination, poor ventilation, electrical hazards, loco movements, unmanned crossings, unpreparedness for emergencies, unsafe scaffoldings, over confidence and working without safety appliances, personal protective equipments (PPEs), written clearances, and shutdown clearances etc. Violation of safety protocols and shut down procedures etc. are also cause of hazards.

Common causes of hazard:

- slips, trips and falls on the same level;
- falls from height;
- unguarded machinery;
- falling objects;
- working in confined spaces;
- moving machinery, on-site transport, forklifts and cranes;
- exposure to controlled and uncontrolled energy sources;

- exposure to asbestos;
- exposure to mineral wools and fibres;
- inhalable agents (gases, vapours, dusts and fumes);
- skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers);
- contact with hot metal;
- fire and explosion;
- extreme temperatures;
- radiation (non-ionizing, ionizing);
- noise and vibration;
- electrical burns and electric shock;
- manual handling and repetitive work;
- failures due to automation;
- ergonomics;
- inadequate accident prevention and inspection;
- inadequate emergency first-aid and rescue facilities;

6.2.4 Control measures

To ensure the health, safety and security of yourself and others, you have to follow the following methods:

- Carry out assigned tasks and duties in a safe manner, in accordance with instructions, and to comply with safety rules/procedures, regulations and codes of practice.
- If aware of any unsafe practice or condition, or if in any doubt about the safety of any situation, consult with the supervisor.
- Wear PPE all the time at workplace.
- Obtain and use the correct tools/equipment for the work and not to use any that are unsafe or damaged. All tools, equipment and personal protective equipment must be stored in the approved place after use.
- Ensure that all guards are securely fixed and that all safety equipment and personal protective clothing/equipment provided are used
- Not to operate any equipment unless authorized.
- To report any accident, near-miss, dangerous occurrence or dangerous condition to their line management.

- To switch off and secure unattended plant or equipment.
- To avoid improvised arrangements and suggest safe ways of eliminating hazards.
- Not to participate in horseplay or place fellow employees in danger by their actions.
- Always attend the health and safety training sessions organized by organization.

Unit 6.3: Safe working practices

Unit Objectives

At the end of this unit, you will be able to:

1. Discuss about safe working practices
2. Know about material safe handling
3. Know about personal protective equipments

6.3.1 Safe working practices

Safe practices for avoiding general shop hazards

- Never use compressed air to blow chips away from a machine
- Keep the floor clear of stock and tools, and clean spilled oils or coolants
- Know where the fire extinguisher is kept and how to use it
- Always keep machines turned off when making adjustments to them

Safe practices for avoiding machine hazards

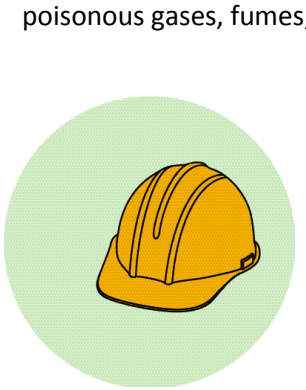
- Before using a machine, think about what you are going to do before doing it
- Go over the following safety checklist before operating a machine:
    1. Am I familiar with the operation of this machine?
    2. What are the potential hazards involved with using this machine?
    3. Are all safety guards in place?
    4. Are my procedures safe?
    5. Am I doing something that I probably should not do?
    6. Have I made all the proper adjustments and tightened all locking mechanisms?
    7. Is the workpiece secured properly?
    8. Do I have proper safety equipment?
    9. Do I know how to turn off the machine quickly if necessary?
    10. Do I think about safety in everything I do?

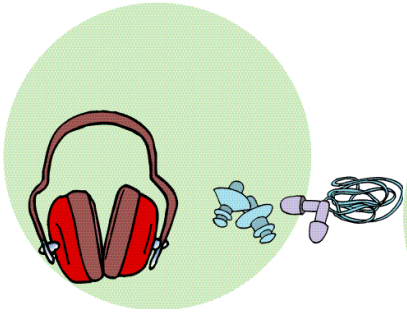
6.3.2 Personal protective equipment (PPE)

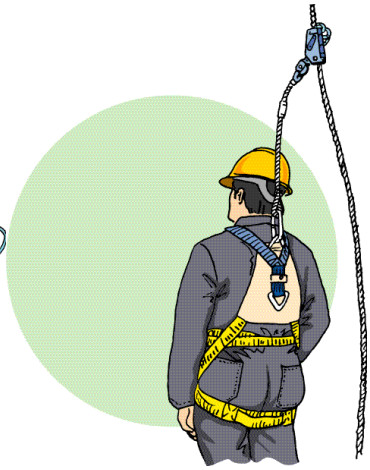
Personal protective equipment serves as the last resort for controlling hazards and is one, but not the only, ancillary or temporary measure. To make full and proper use of personal protective equipment, one should first make sure that the equipment can fulfil the working requirements, conform to the required standards, fit the body shape of the user, be user-friendly, and is under regular maintenance and can be replaced if necessary.

Personal Protective Equipment

- **Safety helmet:** Safety helmets protect the head of the wearer from injuries caused by falling or wavering objects.
- **Earmuffs, earplugs**: Earmuffs and earplugs protect the ears of the wearer from injuries by loud noises.
- **Safety belt**: Safety harnesses protect workers from falling from heights.
- **Goggles, visor:** Goggles and visors protect the eyes of the wearer from injuries caused by strong light or flying objects.
- **Safety boots:** Safety boots protect the feet of the wearer from injuries, puncture wounds and slipping.
- **Respirator**: Respirators protect the respiratory system of the wearer from the attack of poisonous gases, fumes, mist and dust.







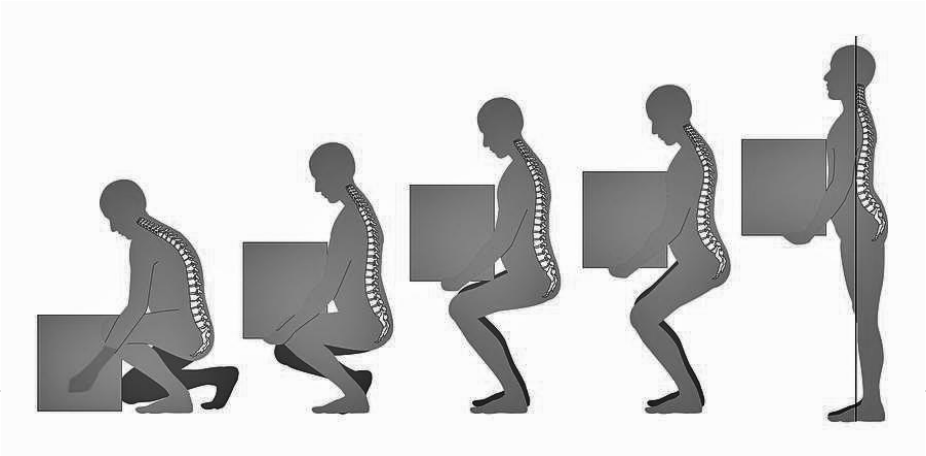
6.3.3 Safe material handling

Every worker has to lift and move heavy weight during the job whenever required. He may be required to move the job manually or by using forklift for lifting and moving. Extreme care should be taken while lifting or moving the job so that no damage occurs to the job or plant and also to prevent accidents at work place.

- Lifting and moving the job manually
- Lifting or moving the job using fork lift
- Assist in lifting of heavy job
- Attaching the job to the overhead crane's sling / hook in a proper and balanced manner.

Points to be taken care of while lifting / moving material

- Lift the materials in correct posture.
- Do not try to lift too heavy materials alone.
- Ensure the grip is right so that the job doesn't slip from hand and fall
- Put down the job at the destined place properly.
- Do not throw the job on ground.
- Avoid double handling.
- Take rest breaks during heavy or repetitive work



Material handling equipments Eliminate the need to lift or lower manually by using handling equipments that can use assist you. Few types of equipment are:

- Trucks
- Forklifts
- Dollies
- Carts
- Wheelbarrows
- Hoists

Make loads easier to push or pull by ensuring the use of:

- carts, hand trucks and dollies with large diameter casters and good bearings, and
- grips or handles on loads or mechanical aids,

Wrong handling can cause:

- Strain & sprains
- Neck and back injuries
- Slips falls and crush accidents
- Cuts, bruises and broken bones
- Hernia
- Occupational overuse syndrome (OOS), also known as repetitive strain injury.

Unit 6.4: Working at heights and confined spaces

Unit Objectives

At the end of this unit, you will be able to:

1. Know about risks of working at heights
2. Know about safety precautions while working at heights
3. Know about risks of working at confined spaces
4. Know about safety precautions while working at confined spaces

6.4.1 Safe working at heights

Falls from height are responsible for many serious and fatal injuries every year. If a person falls from a height above two meters the likelihood is that they will sustain serious injury.

Many work activities involve working at height. Working from ladders, scaffolds and platforms are obvious examples, but there are many more activities where people are required to work at height. Examples include roof work, working over tanks and pits, at the edge of elevated structures, or on top of vehicles or trailers.

The main hazards associated with working at height are people falling and objects falling onto people below. These may occur as a result of inadequate edge protection, or from objects in storage being poorly secured.

6.4.1.1 Assessing risks from working at height

If work at height cannot be avoided, a risk assessment should be carried out before any work at height is undertaken. The assessment should highlight the measures that must be taken to ensure people are not at risk of falling from height.

The risks associated with working at height must be assessed. The Health and Safety Executive recommends a five-step approach to risk assessment, and the risk of slips, trips and falls should also be considered.

6.4.1.2 Steps: How to assess risk

Step 1 Look for hazards associated with falls from height around the workplace. Where are people required to work at height? Do they carry out work from ladders, platforms, scaffolds, or unprotected or fragile roofs?

Step 2 Decide who might be harmed and how. Who comes into the workplace? Are they at risk? Are some groups more at risk than others?

Step 3 Consider the risks. Are there already measures in place to deal with the risks? Look at areas with unguarded openings or without guardrails and covers. Are regular inspections carried out?

Step 4 Record your findings if you have five or more employees.

Step 5 Regularly review the assessment. If any significant changes take place, make sure that precautions are still adequate to deal with the risks.

6.4.1.3 Safe working practices at height

Safe working procedures or ways while working at heights:

Mobile elevated platforms

- use the platform only on level, firm ground
- only use the equipment with outriggers and stabilizers
- work with a trained operator at ground level
- safety harnesses must be worn while on the platform
- keep the platform within safe working limits and radius, taking account of wind speeds.

Scaffold towers: Scaffold towers should:

- be erected by a competent person
- have a height to base dimension ratio not exceeding 3 to 1 indoors, or 2.5 to 1 outdoors
- have stabilizers deployed as necessary to meet the correct height to base ratio
- use outriggers or stabilizers if above 2.5 m high
- have all casters firmly locked before use
- have ladder access to the working platform
- never be moved while the tower is occupied

- be regularly inspected and maintained.

Safety lines, harnesses and nets

Fall restraint and arrest equipment such as nets, airbags and harnesses, etc. should only be considered as a last resort when no other means are reasonably practicable.

Ladders: Ladders are acceptable only for access or work of short duration.

They should be:

- erected at correct angle (4 up to 1 out)
- secured (preferably at top) or footed
- positioned close to the work to avoid over-reaching
- Sufficiently protected at the base of any ladder or access equipment to prevent pedestrians or vehicles bumping into them.

Stepladders: When using stepladders the following precautions should be taken:

- always spread them to their full extent and lock them off
- do not work on the top platform
- do not use the top tread, tool shelf or rear part of the steps as a foot support
- only one person should be on the ladder at any one time
- The ladder must be appropriate and of the correct grade for the intended use.

Access equipment

- any hired equipment must be fit for the purpose. Hire contractors must provide information about the risks involved.
- all access equipment must be properly maintained and regularly inspected
- those erecting and using access equipment must be competent to do so, and training should be provided where necessary
- precautions must be taken to prevent the fall of objects or persons
- do not increase reach by placing ladders on access equipment.

Safety lines, harnesses and nets

Fall restraint and arrest equipment such as nets, airbags and harnesses, etc. should only be considered as a last resort when no other means are reasonably practicable.

6.4.1.4 Dos and don’ts of working at height

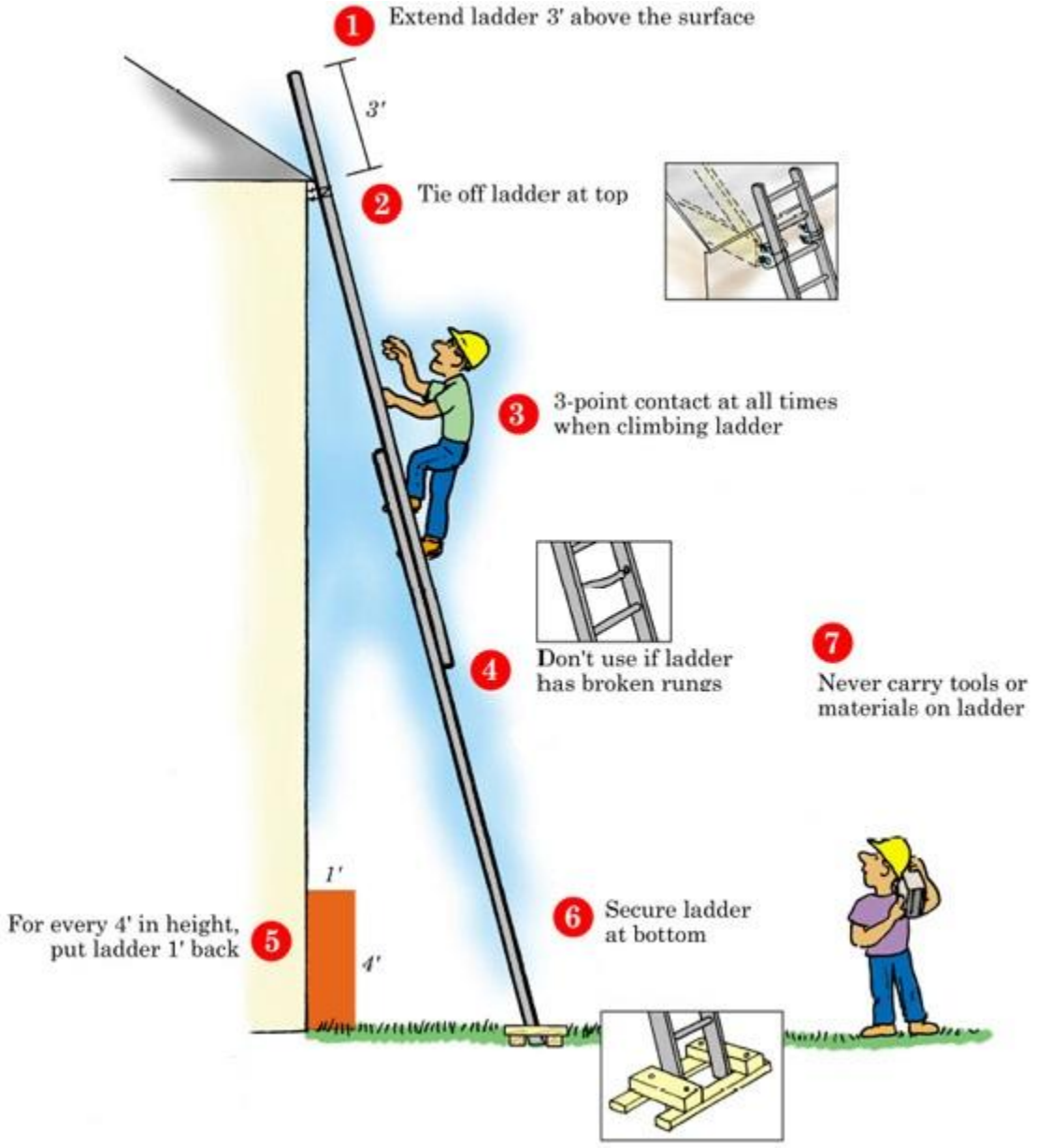
Do….

- as much work as possible from the ground
- ensure equipment is suitable, stable and strong enough for the job, maintained and checked regularly
- take precautions when working on or near fragile surfaces
- provide protection from falling objects
- consider emergency evacuation and rescue procedures

Don't…

- Overload ladders – consider the equipment or materials workers are carrying before working at height.
- Overreach on ladders or stepladders
- Rest a ladder against weak upper surfaces, e.g. glazing or plastic gutters
- Use of ladders or stepladders for strenuous or heavy tasks.

2.4.1.5 Way of using ladder safely



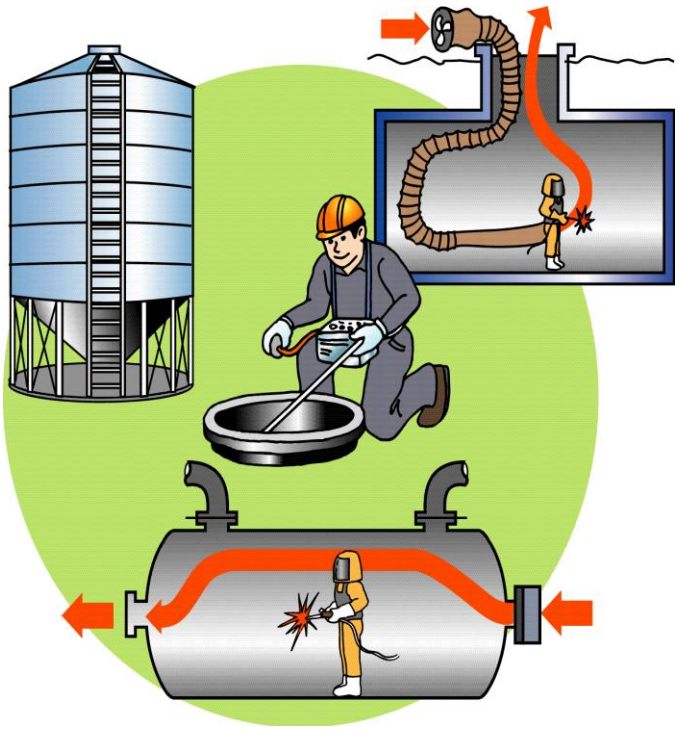
6.4.2 Safe working at Confined spaces

What is a confined space? It can be any space of an enclosed nature where there is a risk of death or serious injury from hazardous substances or dangerous conditions. Some confined spaces are fairly easy to identify, e.g. enclosures with limited openings:

- storage tanks;
- silos;
- reaction vessels;
- enclosed drains;
- sewers.

Others may be less obvious, but can be equally dangerous, for example:

- open-topped chambers;
- vats;
- combustion chambers in furnaces
- ductwork;
- poorly ventilated rooms.



6.4.2.1 Dangers at Confined spaces

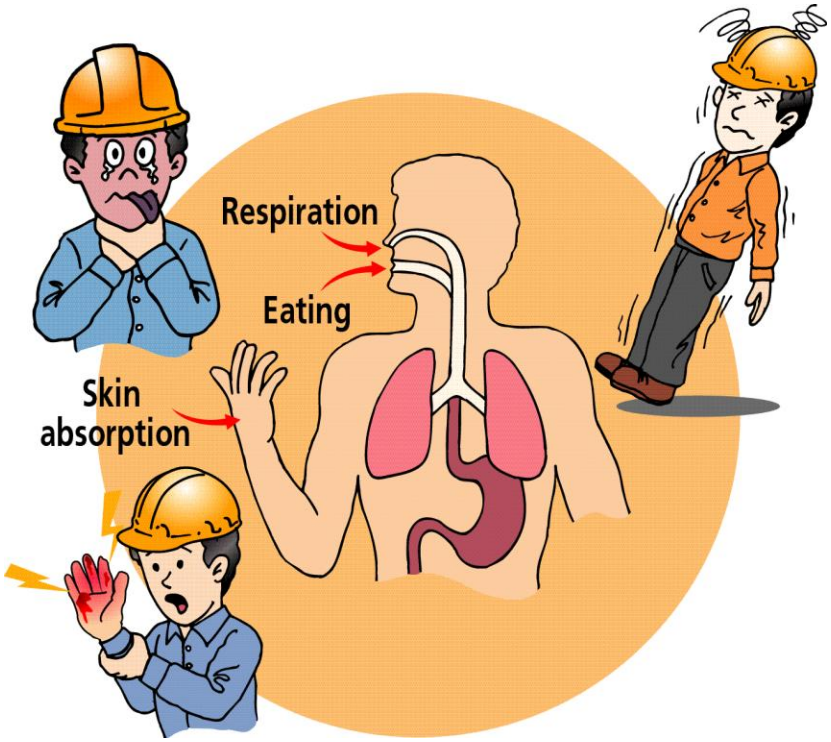
Dangers can arise in confined spaces because of the following issues.

- A lack of oxygen. This can occur:
    - where there is a reaction between some soils and the oxygen in the atmosphere;
    - following the action of groundwater on chalk and limestone which can produce carbon dioxide and displace normal air;
    - in ships' holds, freight containers, lorries etc as a result of the cargo reacting with oxygen inside the space;
    - inside steel tanks and vessels when rust forms.
- Poisonous gas, fume or vapour. These can:
    - build-up in sewers and manholes and in pits connected to the system;
    - enter tanks or vessels from connecting pipes;
    - leak into trenches and pits in contaminated land, such as old refuse tips and old gas works.

- Liquids and solids which can suddenly fill the space, or release gases into it, when disturbed. Free-flowing solids such as grain can also partially solidify or ‘bridge’ in silos, causing blockages which can collapse unexpectedly.
- Fire and explosions (e.g. from flammable vapours, excess oxygen etc).
- Residues left in tanks, vessels etc, or remaining on internal surfaces, which can give off gas, fume or vapour.
- Dust present in high concentrations, e.g. in flour silos.
- Hot conditions leading to a dangerous increase in body temperature.

Some of the above conditions may already be present in the confined space. However, some may arise from the work being carried out, or because of ineffective isolation of plant nearby, e.g. leakage from a pipe connected to the confined space. The enclosure and working space may increase other dangers arising from the work being carried out, for example:

- machinery being used may require special precautions, such as provision of dust extraction for a portable grinder, or special precautions against electric shock;
- gas, fume or vapour can arise from welding, or by use of volatile and often flammable solvents, adhesives etc;
- if access to the space is through a restricted entrance, such as a manhole, escape or rescue in an emergency will be more difficult.

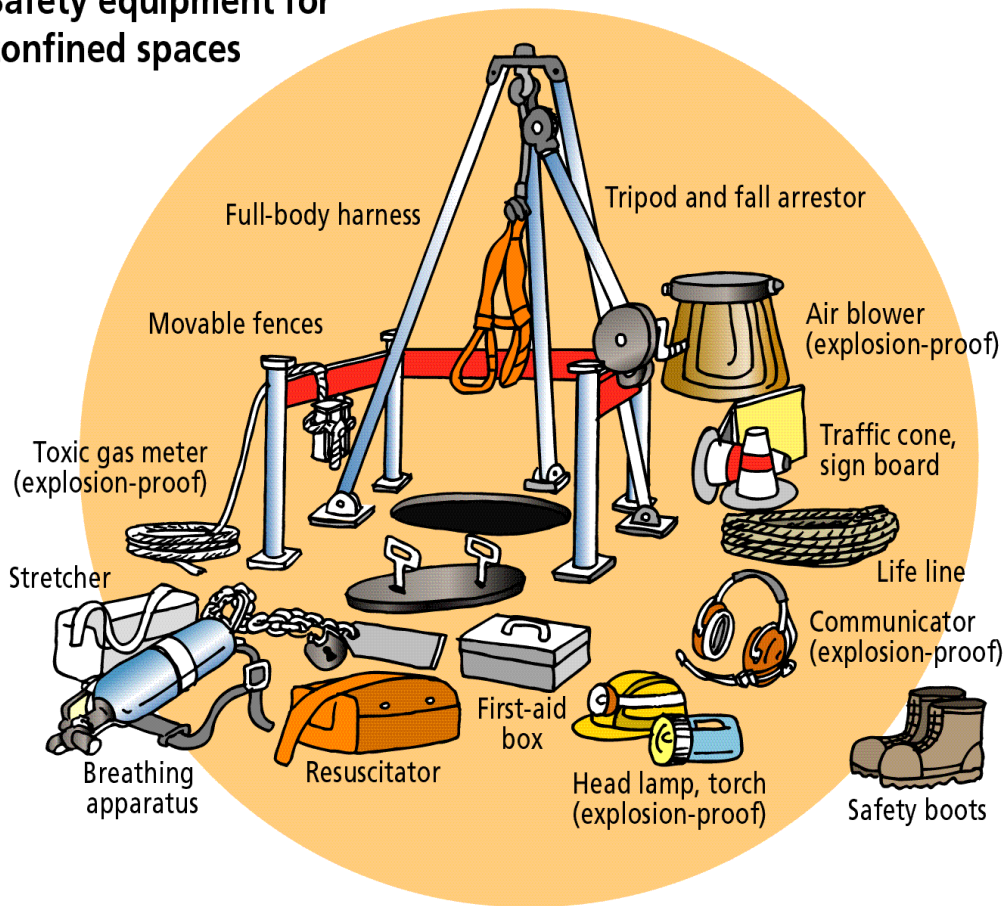


6.4.2.1 Safe systems of work at Confined spaces

If you cannot avoid entry into a confined space, make sure you have a safe system for working inside the space. The following checklist is not intended to be exhaustive, but includes many of the essential elements to help prepare a safe system of work.

- **Isolation:** Mechanical and electrical isolation of equipment is essential if it could otherwise operate, or be operated, inadvertently. If gas, fume or vapour could enter the confined space, you need to isolate the pipework. In all cases, a check should be made to ensure isolation is effective.
- **Cleaning**: before entry This may be necessary to ensure fumes do not develop from residues etc while the work is done.
- **Check the size of the entrance**: Is it big enough to allow workers wearing all the necessary equipment to climb in and out easily, and provide ready access and exit in an emergency? For example, the size of the opening may mean choosing air-line breathing apparatus in place of self-contained equipment which is more bulky and therefore likely to restrict ready passage.
- **Provision of ventilation**: You may be able to increase the number of openings and therefore improve ventilation. Mechanical ventilation may be needed to make sure there is an adequate supply of fresh air. This is essential where portable gas cylinders and diesel-fuelled equipment are used inside the space because of the dangers from build-up of engine exhaust.
- **Provision of special tools and lighting:** Non-sparking tools and specially protected lighting are essential where flammable or potentially explosive atmospheres are likely. In certain confined spaces (e.g. inside metal tanks) suitable precautions to prevent electric shock include use of extra low voltage equipment (typically less than 25 V) and, where necessary, residual current devices.
- **Provision of breathing apparatus:** Breathing apparatus is essential if the air inside the space cannot be made fit to breathe because of gas, fume or vapour present, or lack of oxygen. Never try to ‘sweeten’ the air in a confined space with oxygen as this can greatly increase the risk of a fire or explosion.
- **Preparation of emergency arrangements:** Emergency arrangements will need to cover the necessary equipment, training and practice drills.
- **Provision of rescue harnesses:** Lifelines attached to harnesses should run back to a point outside the confined space.
- **Emergency procedures**: When things go wrong, people may be exposed to serious and immediate danger. Effective arrangements for raising the alarm and carrying out rescue operations in an emergency are essential. Contingency plans will depend on the nature of the confined space, the risks identified and consequently the likely nature of an emergency rescue. Emergency arrangements will depend on the risks. You should consider communications and rescue and resuscitation equipment.

Safety equipment for confined spaces



Notes

Unit 6.5: Fire prevention

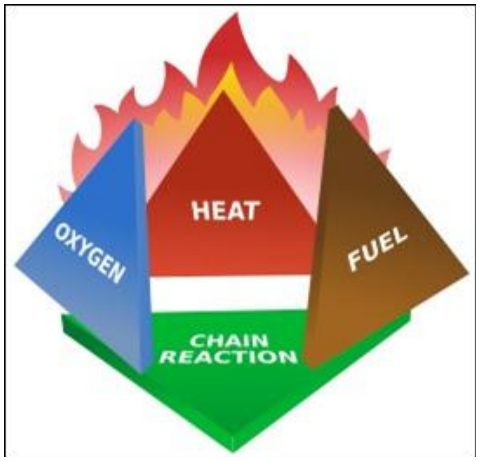
Unit Objectives

At the end of this unit, you will be able to:

1. Know about fire hazards and how to control
2. Know about fire extinguishers

6.5.1 Fire hazard

Fire is one of the most common causes of the accidents in establishments. Fire is defined as a self-sustaining combustion process in which a substance (fuel) combines with oxygen in air to produce immense heat and light.



Fire hazards pose threats to life and property. It is, therefore, the prime object of safety systems to detect, remove or reduce the risk of fire threatened by those potential hazards.

The following fire hazards are common at home, in public places, transports and work places:

- All types of flames used for any work
- Electric wires, higher loads, loose connections and old electrical equipment
- All cooking and heat generating appliances
- All works and situations where fire is essential such as welding, cutting, metal casting etc.
- Improper stowage of tools, equipment and items during and at the end of the day's work
- Smoking and personal lighters and matches
- Fireworks, pyro techniques, ammunitions and explosives
- Improper and unauthorized stowage of flammable and hazardous materials and chemicals especially the flammable ones
- Insufficient capacity and numbers of emergency exits and stairs
- Hindrance to sight or reach firefighting equipment, markings and alarm systems

- Insufficient numbers and types of fire extinguishers
- Absence of fire detection and alarm system
- Violation of building and fire codes

6.5.1.1 Types of Fire

Class of Fire	Description	Mode of Extinguishing	Medium of Extinguishing	Type of Extinguisher
A 	Fire involving solid material (fuel) for combustion like wood, paper, cloth, rubber and plastics that melt.	Cooling	Water	• Water • Soda-Acid Type • CO_2 Gas type
B 	Fire involving flammable liquids like petrol, diesel, thinners, cooking oils, paints, wax and plastics that melt	Blanketing	Foam, CO2, Halon, DCP	• Foam • CO_2 • DCP • Halon type
C 	Fire caused by electricity or electric equipment	Cutting off electricity supply	Vaporising liquids, dry powder and CO_2	• CO_2 • DCP • Halon • Dry Sand
D 	Fire involving flammable metals like magnesium, aluminum, titanium	Smothering	Suitable dry powder	• Special DCP extinguisher • Dry sand • Powered Graphite • Talc and Asbestos • Limestone

6.5.2 Fire fighting equipments

1. Fire Extinguishers

It is a portable fire-fighting device formed like a cylinder filled with chemicals. The type of fire extinguisher used depends on the type of fire.

2. Smoke Detectors

It is a device fitted on the roof which gets activated by smoke in case of fire. Once activated, it in turn activates fire alarm or water sprinklers.

3. Fire Alarm System

It is an alarm system which can be manually or electronically operated /activated in case of outbreak of fire. Usually fire alarm system is connected to smoke detectors and gets activated once smoke detectors are triggered.

4. Fire hydrants

There are fire hydrant systems installed in organizations which have outlets and hydrant lines provided at many locations where there are chances of fire hazard.

6.5.3 Fire extinguishers

A fire extinguisher, or extinguisher, is an active fire protection device used to extinguish or control small fires, often in emergency situations. It is not intended for use on an out-of-control fire (i.e., no escape route, smoke, explosion hazard, etc.), or otherwise requires the expertise of a fire department. Common fire extinguishers are:

- **Dry chemical:** This is a powder based agent that extinguishes by separating the four parts of the fire tetrahedron. It prevents the chemical reactions involving heat, fuel, and oxygen and halts the production of fire sustaining "free-radicals", thus extinguishing the fire.

- **Foams**: Applied to fuel fires as either an aspirated (mixed & expanded with air in a branch pipe) or non-aspirated form to form a frothy blanket or seal over the fuel, preventing oxygen reaching it. Unlike powder, foam can be used to progressively extinguish fires without flashback.
- **Water:** Cools burning material. APW (Air pressurized water) cools burning material by absorbing heat from burning material. Effective on class A fires, it has the advantage of being inexpensive, harmless, and relatively easy to clean up.
- **Clean agents and carbon dioxide:** Agent displaces oxygen (CO2 or inert gases), removes heat from the combustion zone or inhibits chemical chain reaction. They are labeled clean agents because they do not leave any residue after discharge which is ideal for sensitive electronics and documents.

Extinguisher		**Type of Fire**				
Color	**Type**	**Solids (Wood, Paper, Cloth)**	**Flammable Liquids**	**Flammable Gasses**	**Flammable Equipment**	**Cooking Oil & Fats**
	Water	Yes	No	No	No	No
	Foam	Yes	Yes	No	No	Yes
	Dry Powder	Yes	Yes	Yes	Yes	No

	Carbon Dioxide (Co2)	No	Yes	No	Yes	Yes

6.5.3.1 Steps for using a fire extinguisher

1. **Pull the Pin** at the top of the extinguisher. The pin releases a locking mechanism and will allow you to discharge the extinguisher.
2. **Aim at the base of the fire,** not the flames. This is important - in order to put out the fire, you must extinguish the fuel.
3. **Squeeze the lever slowly.** This will release the extinguishing agent in the extinguisher. If the handle is released, the discharge will stop.
4. **Sweep from side to side.** Using a sweeping motion, move the fire extinguisher back and forth until the fire is completely out. Operate the extinguisher from a safe distance, several feet away, and then move towards the fire once it starts to diminish. Be sure to read the instructions on your fire extinguisher - different fire extinguishers recommend operating them from different distances. Remember: Aim at the base of the fire, not at the flames!!!!

6.5.4 Fire drills

Conducting a Fire Drill Includes Exercising the Fire Plan:

a) Isolation of fire

- Close doors
- Automatic sprinkler systems

b) Evacuation of immediate area

- Rescue anyone in immediate danger

c) Evacuation of smoke compartment

- Move people through smoke barrier doors
- Move people to specified areas

d) Preparation of floors and building for evacuation

- Gather Medical records
- Residents: Patients glasses, hearing aids, walkers, wheel chairs, etc.

e) Extinguishment of fire

6.5.4.1 Fire drills record

Records shall be maintained for all required emergency evacuation drills and shall include the following information:

1. Identity of the person conducting the drill
2. Date and time of the drill
3. Notification method used
4. Staff members on duty and participating
5. Number of occupants evacuated
6. Special conditions simulated
7. Problems encountered
8. Weather conditions when evacuating outside

9. Time required to accomplish complete evacuation

Fire Drill Report

Facility Name: _____

Address: _____

Date: _____ **Time:** _____ **Shift:** _____
24 Hour Clock

Person conducting the drill: _____
Name & Title

Fire Alarm Activation Method: _____

Drill Location and simulated Conditions: _____

_____

Unusual Conditions: _____
(weather, Remodeling, Temporary exits)

Number of Occupants evacuated: _____ **Total Time of Drill:** _____

Fire Alarm System reset?:_____**Sprinkler System restored?"** _____

Critique: _____

_____

Fire Alarm System tested: _____**Verified by:** _____

Monitoring company received signal at: _____ **Verified by:** _____

6.5.5 Tips during fire outbreak

s no.	Instruction
1	On noticing a fire, immediately start shouting "fire" at top of your voice. Do not wait for the automatic fire alarms to start ringing.
2	Take a fire extinguisher
3	Use extinguisher as per fire type : - Water and co2 fire extinguishers for general fires

	- Foam type extinguishers for oil fires - Co2 fire extinguisher only for electrical fires.
4	Switch off all mains in case of an electrical fire.
5	Do not try to switch off electrical equipments. Cut the power from the main source.
6	do not panic and alert the building fire department
7	Call the fire brigade immediately if the fire seems to be going beyond control.
8	Ensure that the water sprinklers and other fire-fighting equipment have started operating.
9	First priority should be to save people. Help others to safely get out of the floor
10	Alert the nearest hospital to prepare to treat serious burn injuries.

Unit 6.6: Emergencies, rescue and first aid procedures

Unit Objectives

At the end of this unit, you will be able to:

1. Know about basic first aid techniques during electric shock, burns and choking
2. Know about CPR process
3. Know about bandaging process

6.6.1 Free a person from electrocution

It may not be immediately clear, but if you think someone is suffering from electric shock, approach with extreme caution.

Steps

1. **The first step** is to separate the person from the source of electricity as quickly as possible. The best way of doing this is to turn off the supply, for example, by unplugging the appliance or by turning the mains off at the fuse box (consumer unit).
2. If this isn't possible, then try to remove the source of electricity from the person using a piece of insulating material, such as a length of wood.
3. **NEVER touch the person receiving the electric shock** or you could suffer one too.
4. **After removing the person from the source of electricity**, if the person is unconscious call for an ambulance immediately. Only those with the necessary knowledge and skill should carry out first aid.
5. **Where the person is conscious** and seems well, it is still advisable to monitor their condition, as the effects of an electric shock may not be immediately obvious.

6.6.2 First aid victims in case of bleeding, burns, choking, electric shock, poisoning etc

Following are some basic first aid procedures for treating shock, bleeding and wounds, burns, choking, electric shock, eye injury, fainting, heat stroke, hypothermia, and unconsciousness. These techniques

can be used in the workplace or at home and being prepared will help make the most of a serious situation.

6.6.2.1 Shock

Shock can be life threatening. Symptoms include cold sweat, weakness, irregular breathing, chills, pale or bluish lips and fingernails, rapid weak pulse and nausea.

Steps

1. Do not give the victim anything to eat or drink.
2. Lay the victim on his/her back, but do not move him/her if there's a back or neck injury. If the victim is unconscious, vomiting or has severe injury to the lower face or jaw, lay him/her on his/her side and be sure the victim is getting adequate air.
3. Keep the victim warm (not hot) by use of blankets or clothes.
4. Raise the victim's feet and legs with a pillow. (Only do this if it does not cause the victim any pain.)

6.6.2.2 Bleeding and Wounds

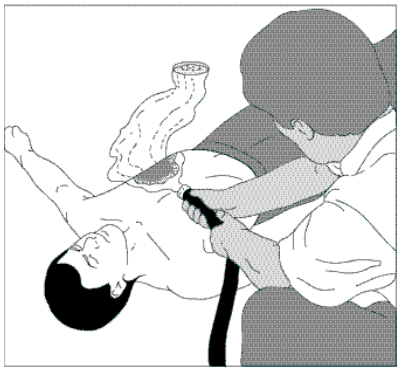
Steps

1. Place a clean cloth or gauze and gloved hand over the wound; apply firm, steady pressure for at least 5 minutes.
2. Elevate an injured arm or leg above the level of the victim's heart if practical.
3. When bleeding stops, secure the cloth with a bandage. Do not lift the cloth from the wound to check if bleeding has stopped. Be sure the bandage is not too tight—it may cut off circulation.
4. Check the victim for shock.

6.6.2.3 Burns

Steps

Chemical or Compressed Gas Burns



1. Use a drench hose, emergency shower or eyewash for at least 15 minutes to rinse away all traces of chemicals while removing any contaminated clothing from the victim.
2. Cover the burn loosely with a clean, dry cloth or special burn dressing.
3. Check the victim for shock.

Heat or Electrical Burns

1. If necessary, use water to stop actual burning of skin.

2. If the skin is not broken, submerse the burned area under cool running water, or gently apply a cool compress until pain is relieved. Bandage with a clean, dry cloth.
3. Do not break a blister if one forms.
4. Do not apply ointments or creams.
5. If skin is broken, or if burns are severe:
    - Do not clean the wound or remove embedded clothing.
    - Cover the burn loosely with a clean, dry cloth.
    - Expect shock and treat accordingly.

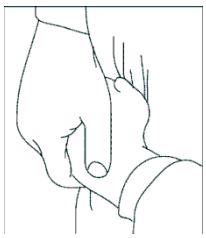
6.5.2.4 Choking

The victim can speak or cough forcibly and is getting sufficient air, do not interfere with his/her attempts to cough the obstruction from the throat. If the victim cannot speak or is not getting sufficient air, have someone call 9-1-1 while you perform abdominal thrusts.

Steps

1. Stand directly behind the victim and wrap your arms around the stomach.

2. Make a fist with one hand and place that fist just above the navel and well below the ribs, with the thumb and forefinger side toward you.



3. Grasp this fist with the other hand and pull it quickly toward you with an inward and slightly upward thrust. Repeat if necessary.

If the victim becomes unconscious:

1. Lay the victim on their back.
2. If the object that is blocking the airway is visible, reach a finger into the victim's mouth (along the inside of the cheek) and try to sweep the obstruction out of the victim's throat, being careful not to push the object deeper into the victim's airway.
3. Even if this is not successful, attempt rescue breathing.
4. If the victim is still not breathing or moving, begin chest compressions (CPR).

6.6.3 Basic techniques of bandaging

The key points when applying a bandage are:

Steps

1. Make sure the person is comfortable.
2. Make sure you work from the side of the injury and do not have to lean across their body.
3. First clean the wound and apply the antibacterial cream over it.
4. Keep the injured part of the body supported in the position it will be in when the bandage is on.
5. Make sure you use the right size bandage.
6. If possible, do not cover fingers or toes when bandaging a limb, so that you can easily check the circulation.
7. Apply the bandage firmly, but not tightly, and secure the end by folding it over and tying a knot in the end. You can also use a safety pin, adhesive (sticky) tape, or a bandage clip.

6.6.4 Artificial respiration and the CPR Process

CPR instructions

- Check the Scene - make sure it is safe for you to help.
- Don't become another victim.

CPR Steps

1. Check the Victim - tap and shout to get response.
2. Circulation - pump the chest 30 times.
3. Place the heel of one hand in the center of the chest and your other hand on top of it. Press chest down 2 inches at a rate of 100 per minute (16 compressions in 10 seconds).

4. Airway - tilt head back, lift chin up to open airway.
5. Breathing - Pinch nose closed, take a normal breath, cover victim's mouth with yours and blow out your breath until you see the chest rise. Give a second breath. Take about 1 second per breath. If chest doesn't rise, open airway again.
6. Repeat procedure until help arrives or the victim begins breathing.

6.6.5 Correct method to move injured people and others during an emergency

There are situations when you need to carry wounded people to medical help or away from further harm. In these cases, you must consider the number of rescuers you have, the abilities of these rescuers and the condition of the victim that must be moved. This article will discuss several ways to carry an injured person:

Steps

1. Stand on either side of the conscious victim. Grab the victim's wrist with the hand closest to the victim's feet on your side.
2. Use your other hand to grasp the clothing on the shoulder nearest to you and pull the victim's arms to help them to a sitting position.
3. Assist the victim to his or her feet and place the arms around your shoulders, if possible.
4. Place your free hand around the person's waist and let him or her set the pace on hobbling out.
5. Help the victim for moving slowly.

7. 5S & House Keeping

Unit 7.1 – Identification of bottlenecks in functioning of work place

Unit 7.2 - Various methods of housekeeping

Unit 7.3 – Waste management

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know about safety issues at workplace
2. Know about 5S safety management system
3. Know about Housekeeping practices
4. Know about benefits of housekeeping
5. Know about elements of effective housekeeping
6. Know about waste management practices

Unit 7.1: Housekeeping and safety issues in industry

Unit Objectives

At the end of this unit, you will be able to:

1. Know about safety issues in industry
2. Know about housekeeping issues in industry

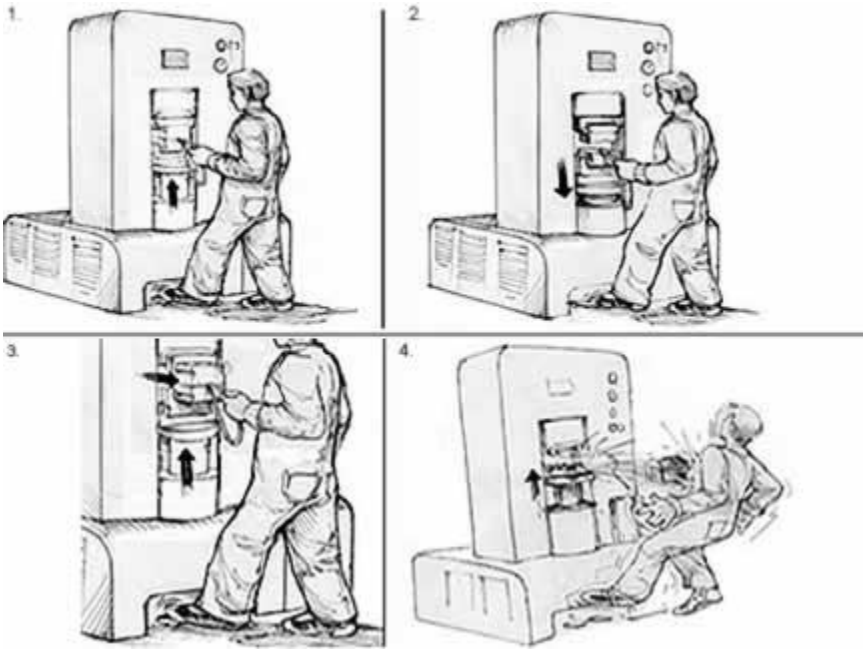
7.1.1 Safety issues in workplace

Exposed wires, fatigued workers, poorly maintained equipment. Manufacturing facilities are riddled with risks, both hidden and out in the open. If you don't know where to begin looking, such hazards can result in serious injury or death.

Below are a few of the biggest safety concerns in any manufacturing setting.

- **Hearing Protection:** Industrial machines produce noise that can affect your hearing if you are exposed to the noise on a prolonged basis. The Occupational Safety & Health Administration requires employers to provide hearing protection when noise levels exceed specific levels. Whether protection is required depends on the sound level and the duration of the exposure.
- **Eye Hazards:** The Vision Council reports that 61 percent of eye injuries occur in the manufacturing, trade and construction industries. Machines can throw dust, metal, concrete and other particles that injure the eyes. Chemical fumes and splashes can also irritate or burn the eyes.

- **Chemical Exposure:** Some manufacturing employees work with dangerous chemicals. For example, workers who produce batteries may be exposed to lead in the form of dust or fumes. Exposure to lead harms the nervous, reproductive and urinary systems, with lead exposure linked to miscarriages, seizures, coma and death.
- **Mechanical Hazards:** Working with manufacturing machines poses several risks to employees. Machines that have gears, sprockets, pulleys and rotating shafts pose risks of entanglement. When a machine has two hard surfaces that move together, employees are at risk of crush injuries. Machines that have sharp edges or perform scissoring actions put workers at risk of cuts, punctures and severed limbs. Employees are also at risk of trip-and-fall accidents if a machine has cables or hoses.



- **Fire Hazards:** The tools and equipment used in manufacturing can produce heat and flame, increasing the risk for fires. Employees should know where to find fire extinguishers and understand how to evacuate the facility immediately in the event of a serious fire.

- **Carbon monoxide poisoning**: Blast furnaces, converters and coke ovens produce large quantities of gases in the process of iron and steel manufacturing. After the dust has been removed, these gases are used as fuel sources in the various plants, and some are supplied to chemical plants for use as raw materials.

  Carbon monoxide sometimes leaks from the tops or bodies of blast furnaces or from the many gas pipelines inside plants, accidentally causing acute carbon monoxide poisoning. Most cases of such poisoning occur during work around blast furnaces, especially during repairs.

- **Dust and fumes**: Dust and fumes are generated at many points in the manufacture of iron and steel. Dust and fumes are found in the preparation processes, especially sintering, in front of the blast furnaces and steel furnaces and in ingot

making. Some lung cancers are thought to be connected with carcinogens found in coke-oven emissions. Dense fumes emitted during the use of oxygen lances and from the use of oxygen in open-hearth furnaces may particularly affect crane operators. Exposure to silica is a risk to workers engaged in lining, relining and repairing blast furnaces and steel furnaces and vessels with refractory materials, which may contain as much as 80% silica.

- In **cold rolling**, there is a risk of trapping between the rolls, especially if cleaning in motion is attempted; nips of rolls should be efficiently guarded and strict supervision exercised to prevent cleaning in motion. Severe injuries may be caused by shearing, cropping, trimming and guillotine machines unless the dangerous parts are securely guarded.
- Severe injuries may be sustained, especially in **hot rolling**, if workers attempt to cross roller conveyors at unauthorized points; an adequate number of bridges should be installed and their use enforced. Looping and lashing may cause extensive injuries and burns, even severing of lower limbs; where full mechanization has not eliminated this hazard, protective posts or other devices are necessary.
- **Miscellaneous hazards**: Bench and top-side operations in coking operations in front of blast furnaces in iron making and furnace-front, ingot-making and continuous-casting operations in steel making all involve strenuous activities in a hot environment. Heat-illness prevention programmes must be implemented.

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Unit 7.2: Various methods of housekeeping

Unit Objectives

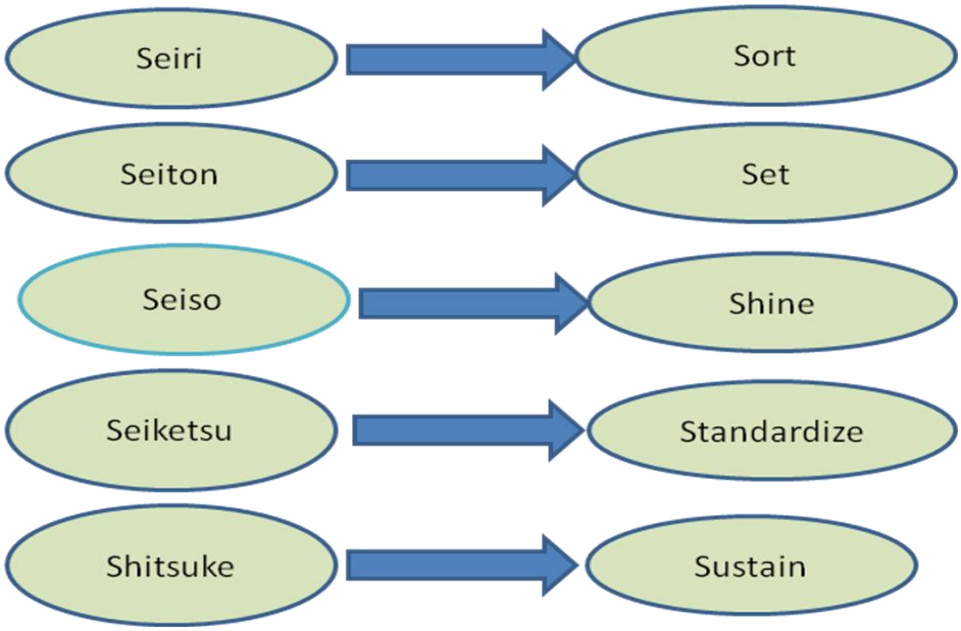
At the end of this unit, you will be able to:

1. Know about 5S Safety system
2. Essential elements Housekeeping
3. Good housekeeping practices

7.2.1 5S Safety management system

What is 5S?

5S is a basic, fundamental, systematic approach for productivity, quality and safety improvement. It is the name of a workplace organization methodology (Japanese Philosophy). It is a list of five Japanese words: *seiri, seiton, seiso, seiketsu,* and *shitsuke* which describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order.



Transliteration of 5S list from Japanese to English

Objectives of 5S:

- Standardize the Manufacturing Process
- Minimize the time lost in searching of tools
- Improve the quality of products and Service

- To increase the production
- Focus on health and safety

Necessity of 5S:

Phases of 5S:

Japanese term	English Term	Meaning in Japanese Context
Seiri	Sort	• Remove unnecessary items and dispose off them properly. • Make work easier by eliminating obstacles. • Reduce chance of being disturbed with unnecessary items. • Prevent accumulation of unnecessary items. • Evaluate necessary items with regard to cost or other factors. • Remove all parts not in use. • Segregate unwanted material from the workplace. • Need fully skilled supervisor for checking on regular basis. • Don't put unnecessary items at the workplace & define a

		red-tagged area to keep those unnecessary items. • Waste removal.
Seiton	Set	• Arrange all necessary items so they can be easily selected for use • Prevent loss and waste of time by arranging work station in such a way that all tooling / equipment is in close proximity • Make it easy to find and pick up necessary items • Ensure first-come-first-served basis • Make workflow smooth and easy • All above work should be done on regular basis
Seiso	Shine	• Clean your workplace completely • Use cleaning as inspection • Prevent machinery and equipment deterioration • Keep workplace safe and easy to work • Keep work place clean and pleasing to work in • When in place anyone not familiar to the environment must be able to detect problems in 5 seconds within 50 feet.
Seiketsu	Standardize	• Standardize the best practices in the work area. • Maintain high standards and workplace organization at all times. • Maintain orderliness. Maintain everything in order and according to its standard. • Everything in its right place. • Every process has a standard.
Shitsuke	Sustain	• To keep in working order • Also translates as "do without being told" • Perform regular audits • Training and Discipline • Training is goal oriented process. Its resulting feedback is necessary monthly

7.2.1.1 Advantages of 5S

- If tools and materials are conveniently located in uncluttered work areas, Operators

- spend less time looking for items
- This leads to higher workstation efficiency, a fundamental goal in mass production
- A clean and tidy workplace leads to greater well being and increased motivation
- Time saving
- Quick retrieval
- Accidents & mistakes minimized
- Increases space
- Foundation of all qc tools
- Continuous quality improvement
- Smooth working no obstruction

7.2.1.2 5S Audit

Three purposes of conducting regular 5S Audit reviews are:

- Review compliance to the 5S standards for your factory
- Note and address non-compliance – to fix what is wrong!
- Provide a formal opportunity to suggest improvements

The Basic Steps

- Plan for the audit by dividing the workplace into various areas, probably the same ones where different teams conducted the various 5S stages.
- Make a checklist for each area, based on the standards that were set during 5S.

Find out the list of known problems in each area. From the initial 5S sweep, this may include:

- Machines needing repair
- Tool racks
- Signage on tool racks or cabinets or storage shelves; warning signs; “keep clear” markings for corridors; or instruction pages.
- Surplus equipment or materials which were not immediately removed.

During the audit, three key tasks

1. Determine whether known problems have been addressed:

- Does this machine still leak lubricants?
- Is the warning sign in place so people will not walk under this crane?

- Why is this outdated drill press still in the corner?

2. See that standards are being met:

- Are tools left on workbenches?
- Is something missing from a tool rack?
- Is dirt accumulating somewhere?
- Are existing labels still visible and easily read?

3. Note what has not yet been standardized – this is the most creative and difficult part, because it may involve seeing what is missing in an area that seems tidy:

- Why is there no sign over the neat stack of work-in-process materials on that shelf?
- Tools that are not yet labeled
- Do we need all those cans of wing nuts in this assembly area? How many are used in one day?

Effective housekeeping can eliminate some workplace hazards and help get a job done safely and properly. Poor housekeeping can frequently contribute to accidents by hiding hazards that cause injuries.

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

7.2.2 Housekeeping practices

Effective housekeeping can eliminate some workplace hazards and help get a job done safely and properly. Poor housekeeping can frequently contribute to accidents by hiding hazards that cause injuries.

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7.2.2.1 Purpose of workplace housekeeping

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

- tripping over loose objects on floors, stairs and platforms
- being hit by falling objects

- slipping on greasy, wet or dirty surfaces
- striking against projecting, poorly stacked items or misplaced material
- Cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping.

7.2.2.2 Benefits of good housekeeping practices

Effective housekeeping results in:

- reduced handling to ease the flow of materials
- fewer tripping and slipping accidents in clutter-free and spill-free work areas
- decreased fire hazards
- lower worker exposures to hazardous substances (e.g. dusts, vapours)
- better control of tools and materials, including inventory and supplies
- more efficient equipment cleanup and maintenance
- better hygienic conditions leading to improved health
- more effective use of space
- reduced property damage by improving preventive maintenance
- improved morale
- improved productivity (tools and materials will be easy to find)

7.2.2.3 Elements of an effective housekeeping program

Dust and Dirt Removal

In some jobs, enclosures and exhaust ventilation systems may fail to collect dust, dirt and chips adequately. Vacuum cleaners are suitable for removing light dust and dirt. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt may accumulate.

Dampening (wetting) floors or using sweeping compounds before sweeping reduces the amount of airborne dust. The dust and grime that collect in places like shelves, piping, conduits, light fixtures, reflectors, windows, cupboards and lockers may require manual cleaning.

Surfaces

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

Maintain Light Fixtures

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

Aisles and Stairways

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

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

Spill Control

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

Tools and Equipment

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

Maintenance

The maintenance of buildings and equipment may be the most important element of good housekeeping. Maintenance involves keeping buildings, equipment and machinery in safe, efficient working order and in good repair. Broken windows, damaged doors, defective plumbing and broken floor surfaces can make a workplace look neglected; these conditions can cause accidents and affect

work practices. So it is important to replace or fix broken or damaged items as quickly as possible. A good maintenance program provides for the inspection, maintenance, upkeep and repair of tools, equipment, machines and processes.

Waste Disposal

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

Allowing material to build up on the floor wastes time and energy since additional time is required for cleaning it up. Placing scrap containers near where the waste is produced encourages orderly waste disposal and makes collection easier.

Storage

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual materials handling is required. Stored materials should allow at least one meter (or about three feet) of clear space under sprinkler heads.

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

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

Exercise

Prepare a housekeeping checklist of your training center

If housekeeping meets standard then sign (√) or not then sign (x). Also give your comments if not meeting standard

Particulars	Sign	Comments
Aisles • Clean • Well-marked		
Exits and entrances • Clear • Well-marked • Free of ice, snow, water, other obstructions		
Hand and Portable Tools • Properly stored when not in use		
Fire Fighting Equipment • Clearly marked • Accessible		
Floors • Clean • Clear • Well-drained		
Ladders • In good condition • Free of grease/oil • Secure when in use		
Lighting • Adequate		
Machines • Clean • Clear • In good condition		
Signs, Tags • Adequate • Appropriate • Clean		
Stacking and Storage • Aisles clear • Stacks stable, secure • Well labeled • Area clean and clear		

Stairs • Non-slip tread • Clean • Clear		
Ventilation System • Clean • Clear		
Waste Disposal • Adequate number of bins • Separate and approved containers for oily rags, flammable scraps, etc		

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Unit 7.3: Waste management

Unit Objectives

At the end of this unit, you will be able to:

1. Know about 5S Safety system
2. Essential elements Housekeeping
3. Good housekeeping practices

7.3.1 Waste management

Waste management is the collection, transport, processing, recycling or disposal of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce the effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it.

Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each.

Wastes typically may be classified as follows:

- Garbage: decomposable wastes
- Rubbish: non decomposable wastes, either combustible (such as paper, wood, and cloth) or non-combustible (such as metal, glass, and ceramics)
- Ashes: residues of the combustion of solid fuels
- Sewage-treatment solids: material retained on sewage-treatment screens, settled solids, and biomass sludge
- Industrial wastes: such materials as chemicals, paints, and sand

- Mining wastes: slag heaps and coal refuse piles

7.3.2 Elements of waste management strategy

Good waste management involves much more than ensuring that wastes are safely and legally disposed of. A typical strategy for the management of industrial waste might contain the following elements:

- Initial audit of wastes produced (source, quantity, composition and hazards) and current waste management procedures.
- Risk assessment to ensure that storage and handling procedures do not present a health, safety or environmental risk.
- Investigation of opportunities for waste reduction, reuse, recycling and recovery assessment of waste treatment options.
- Determination of Best Practicable Environmental! Option for disposal of remaining wastes and treatment residues
- Audit of potential waste management contractors and selection of the contractor offering the best service.

7.3.2 Methods of waste management

1. Segregation

Building materials, plastics, glass and waste from the site work could take a really long time period to decompose. This is the actual reason, why waste separation using container unit is so necessary. Thus, it is very required to maintain green practices so waste management should be done with proper segregation. Thus we make sure to assist you in eliminating hazardous waste from compostable organic waste, non-hazardous solid waste, recyclable materials and other regulated material.

2. Composting

This waste management process turns waste into organic compounds that you can use to feed plants. In terms of the environment advantages this is actually beneficial technique. Making use of this method, it's easy to turn unsafe organic products into safe compost.

3. Burning

If your approach is not towards disposing materials and other wastes, then burning method will be a good approach for you. If waste is bio-degradable or cannot produce hazardous gases after burning, you can burn the waste

4. Job understanding requirements

Unit 4.1 – Limits, fits and tolerances

Unit 4.2 – Understanding the engineering drawing

Unit 4.3 – Hand tools

Unit 4.4 – Measuring instruments

Unit 4.5 – Diagnosing defects in tools and instruments

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know about limits, fits and tolerances
2. Know about engineering drawing
3. Know about tools used
4. Know about use of measuring instruments
5. Know about how to calibrate instruments

8. Reporting and documentation

Unit 8.1 – Documentation for health and safety

Unit 8.2 – Documentation of defects

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know about reporting and documentation requirements
2. Know about accident reporting
3. Know about reporting of defective tools

Unit 8.1: Documentation for health and safety

Unit Objectives

At the end of this unit, you will be able to:

1. Know about accident and incident reporting
2. Know about how to write reports properly

8.1.1 Accidents and incidents reporting

It is extremely important to report accidents and incidents right away, no matter how minor it may be. Even if the injury is minor or if there is no initial injury and you feel it is not worth reporting, the incident must be documented.

- Reporting and documentation is necessary for several reasons:
- Reporting enables the correction of the situation and helps prevent similar future occurrences.
- If an incident results in long term leave or lost ⍰me and you wish to claim compensation, the proper documentation is required in order to receive approval.
- For legislative purposes, the accident resulted in serious injury to or the death of a worker must be reported
- Accident that involved a major structural failure or collapse of a building, bridge, tower, crane, hoist, temporary construction support system or excavation an incident that involved the major release of a hazardous substance.

Your responsibility requires you to be aware of potential hazards and correct reporting processes. If you notice a potentially hazardous situation, it is important that you report it immediately to management and fill out the appropriate forms.

Hazard reports can take a number of different forms:

- the standard hazard report used by workers for all hazards

- reports of infections
- near-miss incident reports
- reports of damage and faulty tools, equipments and machines
- routine inspection reports
- Behavior incident reports.

8.1.2 Reporting format

Reporting of incidents and accidents is required under the Work Health and Safety (WHS) legislation. Workplaces tend to have well developed reporting procedures in place, which aim to fully understand the accident/incident and prevent any future occurrences through investment in injury prevention, based upon accurate data. Reporting and recording should also facilitate costing and associated financial loss.

Always report an accident to management immediately. There should be a form at each workplace that you (or the person involved) and any witnesses can fill out, where possible, otherwise it can be completed by a health and safety representative (HSR) if necessary. The form should cover the following areas:

- Description of the occurrence – what was the event that occurred, which required this report to be completed?
- Nature of injury or disease – select the most appropriate description from a range of options. What injury or disease happened as a result of the occurrence?
- First aid, medical treatment or hospital admission – this section asks for a description of what was done to treat the injury or disease.
- Part of the body affected – tick off which part or parts of the body were affected as a result of the occurrence.
- Source of injury – what actually caused the person to be injured or acquire a disease? This could be a piece of machinery or other hazardous materials for example.
- Probable cause or causes of injury – how was the source listed above actually responsible for the injury?

- Investigation – this asks a series of questions that seek to find out why the person has been injured or has acquired a disease.
- Notification checklist – this checklist makes sure that everyone who should have been contacted regarding the matter has been contacted and asks whether appropriate action has been taken by the authorities.
- Preventative action – this asks whether or not any action has been taken to prevent the occurrence from happening again.
- Witness details – this part is to be filled out if someone saw the occurrence happen. It is essential if any sort of legal action is to be taken.

8.1.3 Filling reports and documents properly

In completing the documentation effectively, follow the established pro-forma. It is important to make sure that regardless of reporting format, all information is recorded in a manner that is:

- written in proper language
- correct
- timely
- According to organization reporting protocols.

The following suggestions will assist you in accurately completing appropriate reports:

- Use pen, not pencil.
- Do not use erasers or liquid paper. If you need to make a correction, put a line through the word or phrase and write the correction above it. Initial and date the change.
- Be thorough. Write down everything that is important.
- Write your notes as soon as practicable after the incident. Most critical incident reports will specify a time by which the documentation is to be completed.
- Remember that case notes or incident reports may be required in the legal arena. In determining the validity of information, the courts discriminate between facts and opinions. 'Facts' are what is directly observed.

- Use it with particularly important information.
- Be legible
- In describing an event, be clear, organized and sequential. Write down what happened in the order it happened.
- If you have any concerns about the process of documentation, discuss this with management.
- Ensure the report is dated and signed after each entry.

We have looked at a number of aspects of accident/incident reporting, from what we need to report, e.g. equipment difficulties, damage or malfunction to recording to recording forms required, e.g. incident reports, fault reports, accident and prevention reports.

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Unit 8.2: Documentation and Reporting of Defects

Unit Objectives

At the end of this unit, you will be able to:

1. Know about reporting of faulty and damage tools

8.2.1 Reporting of faulty and damage tools

Like accident or incident reporting, reporting of faulty and damaged machine, tools and equipments is also necessary. To reduce the chances of accident or any damage it is very important. Any damaged, faulty or malfunctioning tools, equipment should be immediately withdrawn from use and addressed according to organizational policies and procedures. In general, this may require you to report the damage or fault to management, take action to ensure that you or other workers are not injured or harmed by the equipment by tagging or labeling it with a hazard sign, and/or removing the equipment from the area. You should have to check the following details before doing reporting or providing any repair suggestions:

- Last date of inspection
- Last date of repair and which part was repaired.
- Life cycle of the tool, equipment or machine

In machine or equipment faulty or damage report you have to provide following details:

- Name of the tool or machine
- Registration details of machine
- Who does the inspection of toll and machine before the use
- Trouble or hazard from the defective tool or machine
- Defective part name or number
- Remedial action - Tool or machine has to be discontinue or need repair
- Which process is going to affect due to the faulty machine or tool

- Report whether the machine or tool is performing accurately or precisely.
- Report that there limits, fits and tolerances are set or not according to industrial standards.

9. Problem identification and escalation

Unit 9.1 – Risk management

Unit 9.2 – Escalation matrix

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know about identification of problem
2. Know about risk management process
3. Know about escalation matrix and problem escalation process

Unit 9.1: Risk management

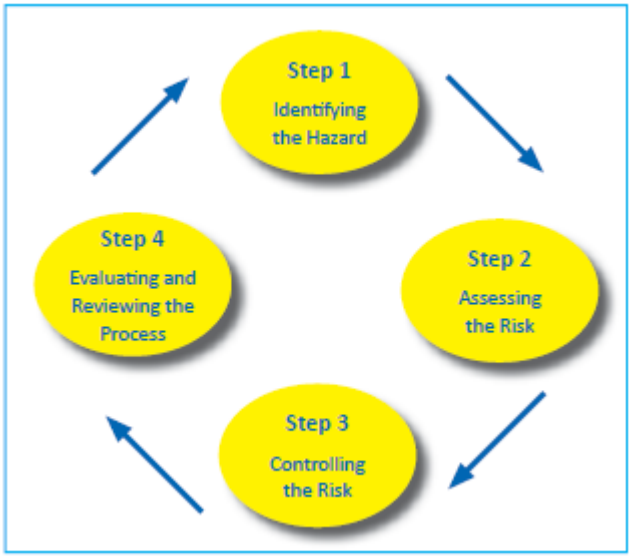
Unit Objectives

At the end of this unit, you will be able to:

1. Know about risk management process
2. Know about inspecting controlling and controlling the problems

9.1.1 Risk management process

To identify problems and suggesting improvements or remedies, you have to follow the specific procedure of risk management. Risk Management involves having a systematic process for addressing hazards in the workplace. It is the process of:



Steps

Step 1: Identifying any foreseeable problem - anything in the workplace that has potential to harm anyone at the workplace, e.g. moving parts in the machinery, toxic chemicals, and manual handling tasks.

Step 2: Assessing the problem - finding out how significant the problem is, e.g. will it cause a serious injury, illness or death and how likely is this to occur?

Step 3: Control the problem or if this is not possible, controlling the risk from the problem - implementing strategies to eliminate or control the problem, e.g. design equipment differently, add machine guards, use safer chemicals, providing lifting devices to minimize manual handling or use personal protective equipment or inform to supervisor or seniors.

Step 4: Reviewing risk assessment - to monitor and improve control measures and find safer ways of doing things.

9.1.2 How to control the problems

Elimination	Control the hazard at the source. Completely remove the hazard.
Substitution	Replace the hazard with something that serves the same purpose but is less harmful.
Engineering	Installing guards, fume hoods, emergency stop buttons, etc.
Administrative	Provide adequate training, use Safe Work Procedures, MSDS's, safety signage
PPE	Wear eye protection, gloves, apron, safety toe boots, hard hat, face shield, ear plugs etc.

9.1.3 Workplace Inspections

One major component of risk management is Workplace Safety Inspections. Inspections are a major tool in ensuring that a workplace remains safe. They help to identify and address new problems or unsafe conditions. Do the inspection according to the inspection checklist made by the organization according to their norms and standards.

After inspection, make an inspection report, which includes the following information:

1. Fill in the name of the area inspected if not already indicated on the sheet, the date and inspectors' names in the area provided. Make sure all pages are attached and kept together with the front page.
2. Check either yes or no according to the situation or item listed, or put a check next to each listed control. If you can't check off the presence of a control, or answer no to any of the questions, this indicates action is needed. To better prioritize action, evaluate the hazard's severity.
3. Record suggested remedial action in the comments for the identified action items. State what needs to be or should be done to correct and better control the hazardous situation.

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Unit 9.2: Escalation matrix

Unit Objectives

At the end of this unit, you will be able to:

1. Know about problem management process
2. Know about escalation matrix

9.2.1 Escalation matrix

For escalating issues to the concerned department, every organization follows a specific procedure. This procedure is based on escalation matrix.

Problem management process

1. Identify problems as described earlier
2. Logging problems – Log the complaint report to the concerned person via email or procedure specified by organization.
3. Categorize problems – categorize the problems into hazards, accidents, faulty tools or equipments and general problems.
4. Prioritization of problem – prioritize the problem according to its impact or severity into high, low, moderate and cri□cal.
5. Initially diagnosis the problem and collect data and information regarding that.
6. Escalate the problem to the management through the escalation procedure.
7. Review the remedial action taken by the management to resolve the situation
8. If found any problem again, then notify the management again about the problem and also suggest the remedial action required for it.

9. Close the complaint after solution of problem.

Escalation matrix is a complaint logging system (complaint box) allows you to specify multiple user contacts to be notified in the event of issues. By using escalation matrix you can notify the right people at the right time about cri□cal alerts irrespective of the business hours. The escalation matrix is time zone specific and it is available 24X7. The key features of escalation matrix are as follows.

- The escalation levels are based on schedules.
- The service is available 24X7 and schedules are allocated accordingly.
- The schedules are □me zone specific.
- A matrix can be defined at multiple levels ranging from senior management to lower management.

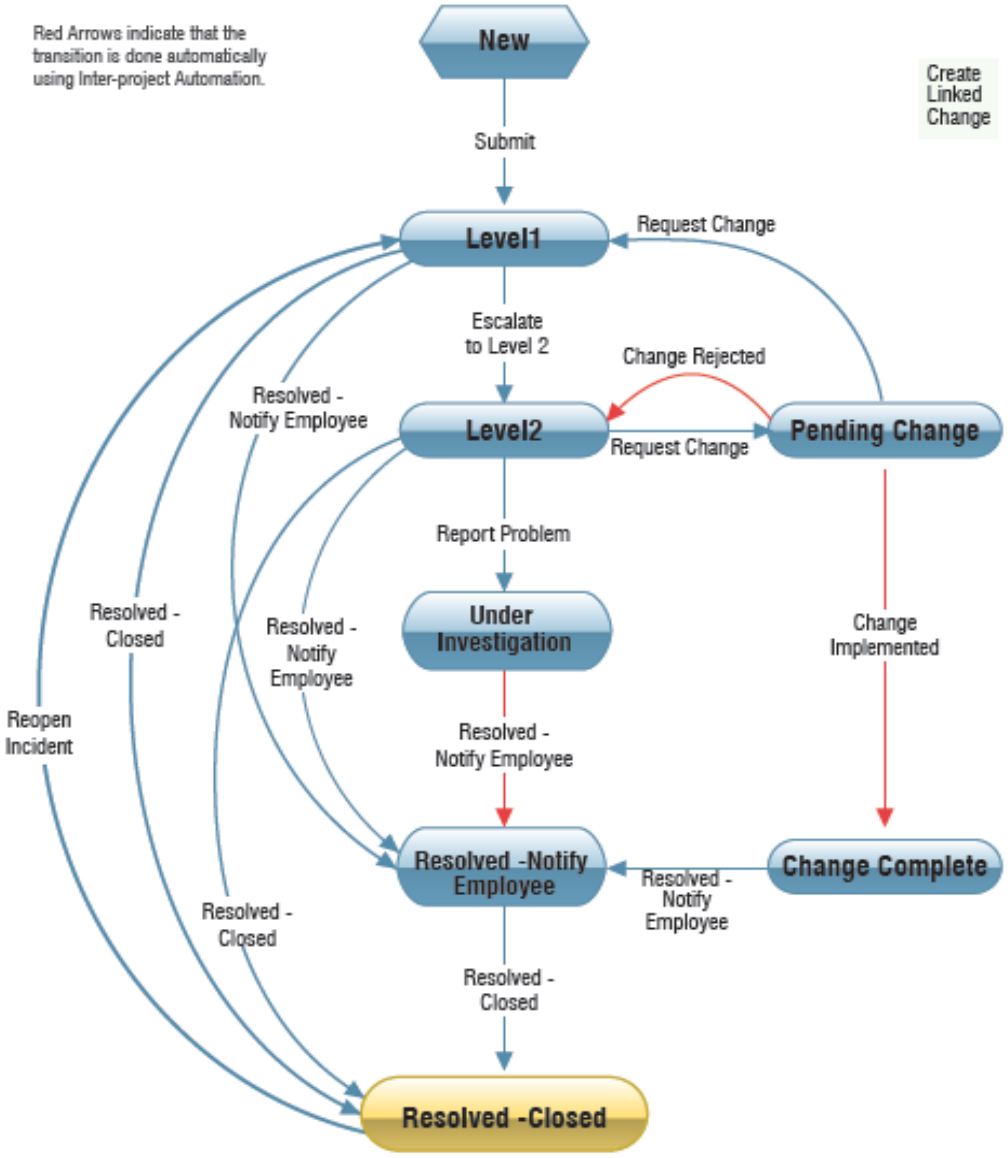
This implies that you can now have exclusive user groups notified of issues depending on device roles or locations or issue types.

9.2.2 How does escalation matrix

In escalation matrix, complaints severity can be assigned into difference levels, Level 1 and can be escalated to next levels. These next levels, say are called Level 2 and Level 3 respectively. Administrators can assign Level 1, Level 2 and Level 3 departments.

Once the Level 1, Level 2 and Level 3 departments are defined, here is the how this works:

1. Complaint of a given category will by default be assigned and notified by email to the Level 1 department of that category.
2. It defines which an issue has to be raised to whom and within which time frame.
3. If the complaint is not resolved within X number of days (X is the time defined for Level 1 department to resolve the issue), the complaint will be escalated to Level 2 department.
4. If the complaint is not resolved within Y number of days (Y is the time defined for Level 2 department to resolve the issue), the complaint will be escalated to Level 3 department.



At every escalation, L1/L2/L3 owners can receive notifications.

This is the process of escalating the issues to your supervisor to your senior management. If you will get any issues, you have to lodge the complaint according to the complaint box system followed by your organization.

Concerns and complaints may be received by any member of staff. It is important that they are dealt with promptly and effectively by following the organizational policies and procedures.

10. Work effectively with others

Unit 10.1 – Ensure appropriate communication with others

Unit 10.2 – Workplace etiquettes

Key Learning Outcomes

At the end of this module, you will be able to:

1. Effective communication with colleagues
2. Workplace etiquettes

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Unit 10.1: Ensure appropriate communication others

Unit Objectives

At the end of this unit, you will be able to:

1. Know about how to communicate effectively with colleagues
2. Know about effective communication

10.1.1 Communicate with others properly

How you treat people says a lot about you. Each colleague plays an important role in the success of the organization.

- People like hearing their own names. Learn your co-workers' names and learn them quickly.
- Don't assume a person is more or less important because of his/her title. Speak to everyone you work with or pass in the hallway. Every employee deserves your respect!
- Self-assess: Think about how you treat your supervisor(s), peers, and subordinates. Would the differences in the relationships, if seen by others, cast you in an unfavorable light? If so, find where the imbalance exists, and start the process of reworking the relationship dynamic.
- What you share with others about your personal life is your choice, but be careful. Your openness may have a negative impact. Don't ask others to share their personal lives with you. This makes many people uncomfortable in the work space.
- Respect other people's personal space. This may be very different than your own.

Sometimes it's not what you say, but how you say it that counts! Proper communication is equally important whether your delivery is spoken, written or implied.

10.1.2 Effective communication with colleagues

Here are some ways to communicate better with your colleagues at work:

- **Listen actively**: Listening actively shows that you're interested in what your colleague has to say and that you respect them. Listen to them closely, orienting your body towards them, and look at them directly as they speak. While they're talking, don't interrupt them. You'll only be able to understand what they're trying to say if you listen to them closely and wait for them to finish speaking before you reply. Then ask questions to clarify any issues you may have. Most importantly, don't email or text while someone's talking to you.
- **Speak with discretion and talk face to face**: Speaking with discretion prevents any misunderstandings with your colleagues. Face to face communication helps with building trust and openness, and it enables you to sense and understand someone's viewpoint and feelings.
- **Offer constructive criticism**: When giving feedback, leave your personal feelings out of it and make sure your workmate fully understands what you're telling them. If someone did a great job, offer positive reinforcement and also give them improvement tips without being mean or bossy.

- **Build and earn trust**: For effective communication to occur, everyone must trust and respect each other. To build trust with your colleagues, it's important that you act consistently and with integrity. To earn their trust, communicate clearly, collaboratively and confidentially with them while showing them respect. Clear and concise communication will allow your colleagues to understand and then trust you.
- **Get personal but don't be too casual**: Get to know your colleagues better by talking about your personal lives during breaks or after work. This is also a good way to build trust. However, it's important that you don't get too casual in your conversations, especially in the office, as it might make the other person uncomfortable.
- **Tell them how what you're communicating is relevant to them**: Your communication is only relevant if it's related to what the other person wants, needs, fears or desires. Figure out how

what you'll say or write is relevant to your colleague and then tell them about it. If what you're communicating is indeed relevant to them, then it will keep them listening to or reading what you're trying to say.

- **Keep spoken and written communications short, simple and direct**: Don't expect your colleague to listen to and read everything that you're trying to tell them because there's just not enough hours in the day. Try to avoid giving them complex explanations and recommendations with the expectation they will understand everything straight away. It's best to keep your communications short, simple and direct.

Unit 10.2: Workplace etiquettes

Unit Objectives

At the end of this unit, you will be able to:

1. Know about organization policies and procedures
2. Know about workplace etiquettes

10.2.1 Follow organization policies and procedures

Organization policies and procedures while working with colleagues:

- Never use abusive words with the colleagues
- Follow work etiquettes
- Never share secret or confidential information with your colleagues
- Help your colleague in case of emergency or difficult situations
- Coach your colleagues in case of problems and about organization policies and procedures.
- Communicate with them properly.

10.2.2 Workplace etiquettes

The way you present yourself to others in the business world speaks volumes about you. Many people form first impressions about others within seconds of meeting them. Whether you're hired in a work study job, an internship or your first full-time job after graduation you must present yourself as a professional. Here are some important tips to help you succeed on the job.

Make a positive impression

Making a good impression on the job can improve your overall image and your confidence.

- When you enter your workplace at the beginning of your day, greet each of your colleagues.

- When a co-worker is speaking to you stand straight, make eye contact, turn towards them and listen attentively.
- Verify and follow the employer's office dress code. NEVER assume you can wear casual attire to work.
- Your bag or purse and the things you carry in them say something about you. Messy items may detract from the image you would like to present.
- When meeting someone for the first time, smile and shake hands palm to palm with a gentle firmness.
- Sleepiness has a negative effect in the workplace. Be alert and ready to contribute to the company.
- Arrive at work a few minutes early each day. Put your personal items away and then be ready to begin your workday.
- Remember, kindness and courtesy always count!

Cooperate with colleagues

How you treat people says a lot about you. Each colleague plays an important role in the success of the organization.

- People like hearing their own names. Learn your co-workers' names and learn them quickly.
- Don't assume a person is more or less important because of his/her title. Speak to everyone you work with or pass in the hallway. Every employee deserves your respect!
- Self-assess: Think about how you treat your supervisor(s), peers, and subordinates. Would the differences in the relationships, if seen by others, cast you in an unfavourable light? If so, find where the imbalance exists, and start the process of reworking the relationship dynamic.
- What you share with others about your personal life is your choice, but be careful. Your openness may have a negative impact. Don't ask others to share their personal lives with you. This makes many people uncomfortable in the work space.
- Respect other people's personal space. This may be very different than your own.

Work space savvy

It’s possible you may spend more waking hours in your work space than in your home.

- Keep your work space professional and neat with appropriate personal touches! People will see the space and consider it a reflection of you.
- Whether it is a cubicle or office, respect others' space. Don't just walk in; knock or make your presence gently known. Ask your colleague if they have a few minutes to speak with you. Don't assume acknowledgement of your presence is an invitation to sit down; wait until you are invited to do so.
- Don’t interrupt people on the phone. You could damage an important phone call.
- Limit personal calls, especially if you work in a space that lacks a door.
- Ask your supervisor when and where it is appropriate to use your cell phone in your office.
- AVOID using ear buds or headphones to listen to music while at work.
- Keep food consumption to a minimum. Smells and noise from food can be distracting to others trying to work.

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