Surface Mining

Level-II

Based on December 2018, Version 2 OS and April. 2021, V1 Curriculum

Module Title: Conduct Crushing, Screening and Conveying Operations

LG Code: MIN SMN2 M10 LO (1- 4) LG (36 – 39)

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Adama Ethiopia

April 2021

Table of Contents

LG #36	LO #1-Plan and prepare for operations

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Accessing, interpreting and applying compliance documentation
- Obtaining, interpreting and clarifying work requirements
- Selecting and using personal protective equipment
- Ensuring well ventilated work area
- Inspecting and preparing work area and equipment
- Preparing work plan
- Selecting auxiliary equipment
- Resolving coordination requirements

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Access, interpret and apply compliance documentation
- Obtain, interpret and clarify work requirements
- Select and use personal protective equipment
- Ensure well ventilated work area
- Inspect and preparing work area and equipment
- Prepare work plan
- Select auxiliary equipment
- Resolve coordination requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet1- Accessing, interpreting and applying compliance documentation

1.1 Crushing Operation documentation:

Crushing is the first step of mineral processing where the ore/rocks from the mine site is fed into the mechanical equipment in order to reduce the size of masses for subsequent usage by liberating the valuable mineral from the gangue. A crusher is a machin

e designed to reduce large rocks into smaller rocks, gravel, and sand or rock dust. Crushers may be used to reduce the size, or change the form, of waste materials

1.1.1 Crushing plants:

A crushing plant is a configuration of different production units, such as crushers, screens, conveyors, bins, stockpiles and feeders. The number and configuration of units are dependent on the preferred product and process performance for which the plant and equipment are designed. This can range from a single crusher with a couple of conveyors to multiple reduction stages in combination with a complex system of bins, screens and conveyors. Crushing plants, as a continuous process, are affected by gradual and discrete changes in the process that alter the performance of the entire system. The aim of Mine Plant control is to understand how crushing plants operate under different conditions over time and to develop methods for improving plant performance.

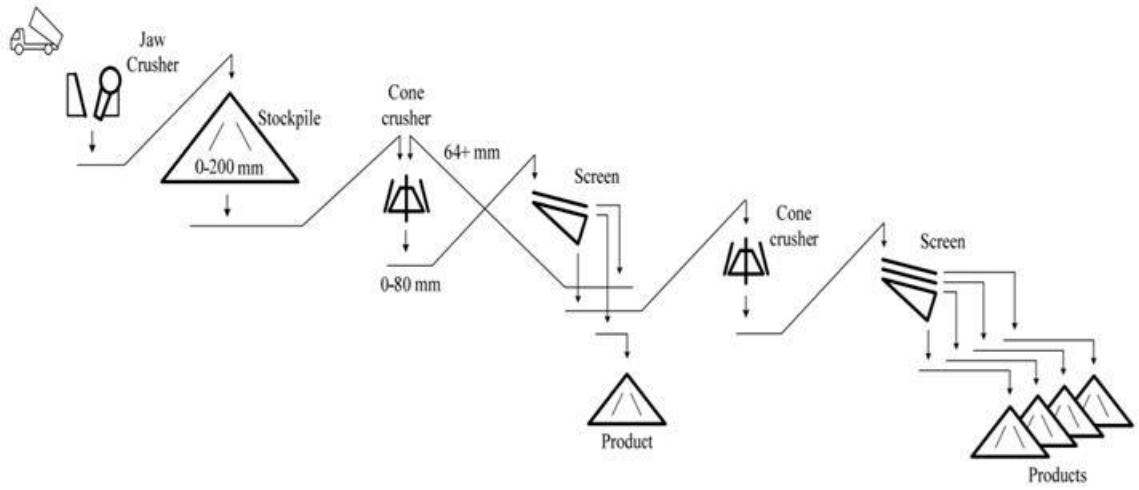

Fig1: Crushing plant

1.1.2 Crushing Plant Design and Layout Considerations:

The fundamental goal for the design of a crushing plant is

- An installation that meets the required production requirements,
- Operates at competitive cost,
- Complies with today's tough environmental regulations, and
- Can be built at a reasonable price despite the rising costs of equipment, energy and construction labor.

Mining is a complex long term activity. The basic element of environmental risk at mining sites has not changed: mines have large pits and generate large amounts of tailings and waste rock. Modern mining often resembles a complex chemical plant rather than a quarry due to the reliance on acids and cyanides. Environmental management of mining requires attention from the very beginning of mine design throughout the life of the mine until closure.

1.2 Environmental, Health and Safety Improvements:

National legislation may place duties on employers or others in control of worksites to ensure that certain documentation (with reference to OSH) is present and up to date. It would be impossible to list all the documentation required by national legislation; however, there may be a requirement for some or all of the following (in no particular order):

- Documented safety and health policy;
- Notice to the authorities providing information with regards to the mining project;
- Site plans;
- Site operating hours;
- Safety and health plans;
- Employee work records; e.g. contracts, contact details, hours of work, training records;
- Method statements covering work activities;
- Risk assessments;
- Accident and occupational disease records;
- Equipment manuals/maintenance records/examination records;

- **Implement dust control measures: includes**
- Wetting with water or suppressants;
- Wind management.
- Appropriate location away from residential areas or other sensitive receptors;
- Containment of process equipment and storage areas, e.g. dust covers;
- Reduce drop heights;
- Abatement technology, e.g. bag filters;
- Wheel/vehicle washing;
- Control vehicle speeds.

1.3 Regulatory systems:

In basic regulatory systems, the inspector will be involved in inspection, enforcement, and assessment and feedback of information about the effectiveness of the compliance assurance system in achieving policy and regulatory objectives.

- ➔ Conduct environment, health and safety training for all employees and contractors;
- ➔ Good housekeeping should be maintained at all times in all areas to prevent accidents and incidents and reduce waste and visual impact;

In more complex systems the inspector is also likely to have the following tasks:

- Contributing to environmental policy development;
- Contributing to the development of legislation and supporting regulations;
- Promoting voluntary environmental compliance;
- Setting inspection priorities;
- Checking environmental compliance;
- Enforcing the rule of law;
- Assessing and supplying feedback of information to policy makers, legislators, and permit writers;
- Contributing to the implementation of international environmental law.

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention the fundamental goal for the design of a crushing plant.(3pts)
2. List down some of the dust control measures.(3pts)
3. Define what Crushing means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	**Obtaining, interpreting and clarifying work requirements**

2.1 Mining plant Work requirement:

Crushing and screening is the first controlled size reduction stage in the process. This is the main process in aggregate production and a preparation process for further size reduction.

Liberation (size reduction):

Liberation is the second and the most important step in Mineral Beneficiation. The third step, separation, is impracticable if the second step, liberation, is not accomplished successfully.

Liberation: It can be defined as the freeing or detachment of dissimilar mineral grains. The operation employed to liberate the dissimilar mineral grains is Size reduction.

Free particles: If the particles of ore consist of a single mineral, they are termed as Free particles. **Locked particles**: If the particles of ore consist of two or more minerals, they are termed as locked particles. If the locked particles contain valuable minerals at considerable quantity, they are termed as middling particles.

Grain size: It is the size of a mineral as it occurs in the ore.

Particle size: It is the size of any particle whether free or locked particle. Grain and Grain size pertain to uncrushed ore and Particle and Particle size pertain to crushed or ground ore.

Liberation size: It is the size of a mineral particle at which is completely Liberated. It is the size of a free particle of required (valuable) mineral. Various mineral grains, present in the ore, exist in physical combination with each other. To detach the valuable mineral grains from all other gangue mineral grains, it is essential to reduce the size of the ore particles. If one mineral species in an ore is to be separated physically from all other species in the ore, all grains of the desired species must be physically detached from all remaining species in the ore.

The critical design parameters as well as the consideration of ore characteristics, geographical location, climatic conditions, expected operational life, expansion potential, safety, environment, and operability and maintain ability. The fundamental goal for the design of a crushing plant is an installation that meets the required production requirements, operates at competitive cost, complies with today's tough environmental regulations, and can be built at a reasonable price despite

The rising costs of equipment, energy and construction labor.

Fig 1: Site selection and mining plant design

2.2.1 Design parameters:

The principal design parameters that drive crushing plant selection and configuration include:

A Production requirement:

- Capital cost
- Ore characteristics
- Safety and environment
- Project location
- Life of mine/expansion plans
- Operational considerations
- Maintenance requirements
- Climatic conditions

B Operational Considerations

Designers of new plants must be aware of ways of making a plant simple and economical to run; many plant modifications and additions can be justified by reductions in operating costs. The operator should also be able to see all the main parts of the crushing facility under his control, through good direct visibility and by means of TV cameras and monitors. Although spills cannot be avoided, plant layout must facilitate quick and easy cleanup. Provisions should be made for suitable plant cleaning equipment. Wash-down hoses should be located within easy reach throughout the plant. Some operators regularly wash their crushing plants from top to bottom to eliminate dust build-up on the structural steel and equipment. Crushers, chutes and belts are all subject to extensive wear, and wear parts and plates can be heavy.

C Maintenance Requirements:

Plants must be designed for ease of access and maintainability if they are to meet their production goals. Keeping maintenance requirements to a minimum help achieve higher overall operating availability. Scheduled preventive maintenance at crushing plants involves a number of elements, including:

- Crusher wear parts
- Feeder wear parts
- Oil and lubrication
- Visual inspections
- Screen decks
- Conveyor skirting and adjustment
- Conveyor belt repair
- Electrical and instrumentation adjustments.

Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1.What are the Requirements of design parameters that drive crushing plant selection.(3pts)

2.What is the difference between Crushing and screening?(3pts)

3.Define what liberation means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information -3	**Selecting and using personal protective equipment**

3.1 Personal protective equipment:

The purpose of Personal Protective Equipment is to protect employees from the hazards associated with using hand or powered tools at work area. PPE or Personal Protective Equipment is any clothing, equipment or substance designed to protect a person from risks of injury or illness.

Common Protection Equipment

3.2 Personal protective equipment May include:

- ✓ chemical/gas detectors
- ✓ eye protection (e.g. glasses)
- ✓ hearing protection (e.g. ear plugs)
- ✓ protection from the elements (e.g. sun block)
- ✓ respiratory devices
- ✓ safety harness when working at heights

1 Foot Protection:

The mining work boot may be of either leather or rubber construction, depending on whether the mine is dry or wet. Minimum protective requirements for the boot include a full puncture-proof sole with a composite outer layer to prevent slipping

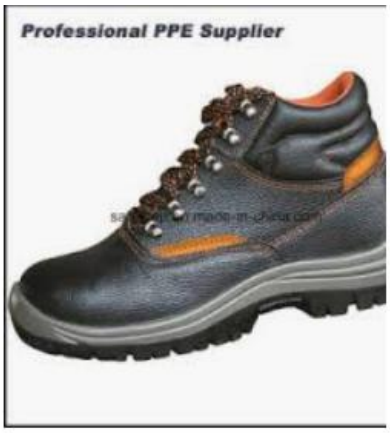

Figure 1: safety boot.

2. Earmuffs:

Earmuffs are used to protect the ears from too much noise in the workplace. The designed is to fully cove

Figure2. Earmuffs

3 Earplugs: Earplugs are used to protect the ears from too much noise in the workplace. The designed is to fully cover the ears.

Figure 3 Earplugs

4. Eye and Face Protection

4.1 Face shield is best for general protection of the face. Commonly worn under a welding helmet.

5 **Safety Goggles** are used to protect the eyes from dust and particles.

Figure 5.Safety goggle

6. **Lung Protection**

The most commonly needed respiratory protection in mining operations is dust protection. Coal dust as well as most other ambient dusts can be effectively filtered using an inexpensive quarter face piece dust mask. Welding, flame cutting, use of solvents, handling of fuels, blasting and other operations can produce air-borne contaminant twin cartridge respirators use to remove combinations of dust, mists, fumes, organic vapors and acid gases which are produced from the above.

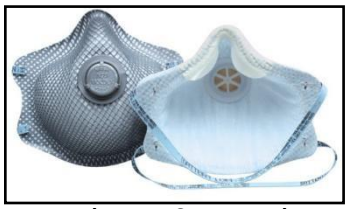

Figure 6: Respirators

7. Hand Protection:

Protect the hands from heat, spatter, dirt or radiations. Properly fitting gloves reduce hand injuries. Wear appropriate gloves to handle core trays and chemicals etc. Drillers should wear close-fitting gloves.

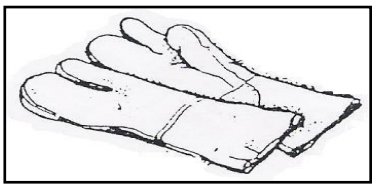

Figure7. Gloves

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the importance of Personal protective equipment in mine plant ?(3pts)
2. Mention some of the Personal protective equipment .(3pts)
3. Define what does Personal protective equipment mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Ensuring well ventilated work area

4.1 Ventilation in the work area:

Ventilation in the workplace is covered under the Workplace (Health, Safety and Welfare) Regulations which state that workplaces need to be adequately ventilated in the proper manner by which clean air is drawn from an external source outside of the workplace and circulated throughout the building. it should dilute and remove humid air and provide sufficient air movement to give a feeling of freshness without causing a draught.

The most basic definition of mine ventilation could be "the science and practice (art!) of providing safe and healthy air for a mine.

- **A mine ventilation system includes:** fans, airways, control devices to direct or restrict air flow, cooling and filtering air and systems for monitoring air quality and quantity.

Benefits of good ventilation systems:

Remove air contaminated with dust from the areas where men and machinery are traveling or working. Blasting is the biggest single source of mine dust and is the most difficult process in which to control the release of dust.

- Control impurities
- Air regulation
- Stop condensation
- Reduce temperatures
- Health benefits
- To dilute & remove gases.

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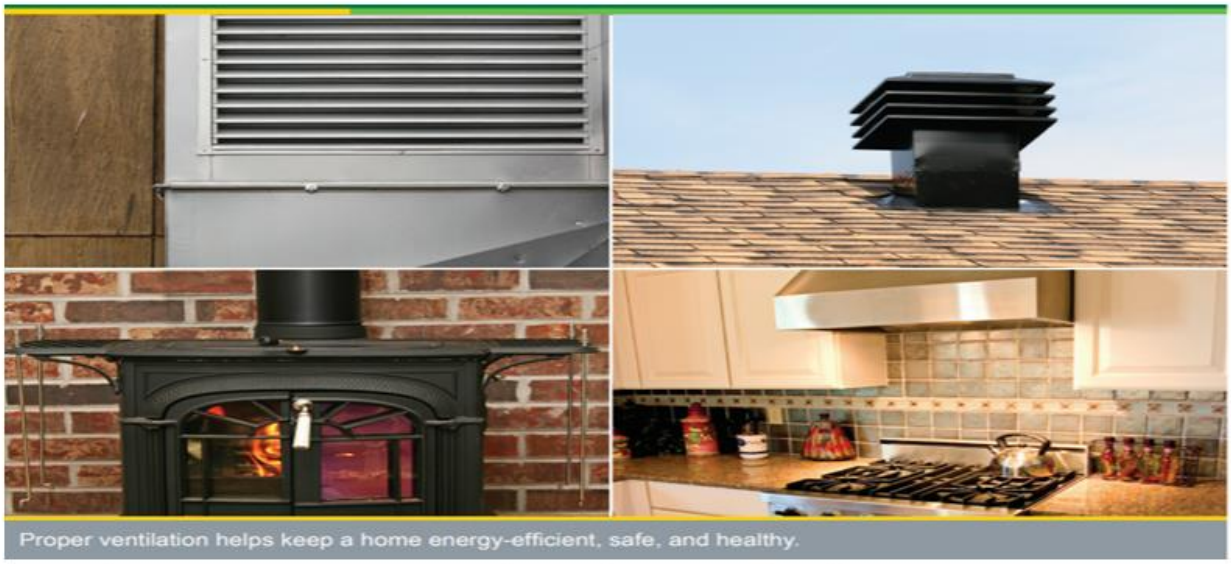
Types of ventilation:

A. Natural ventilation:

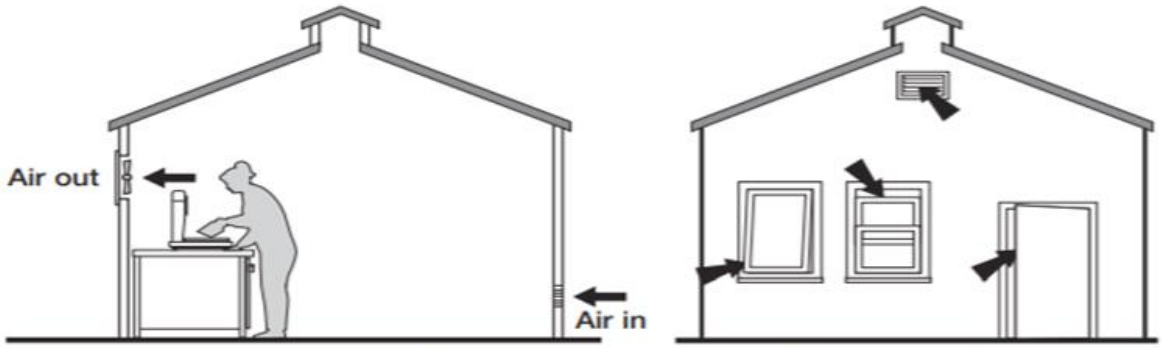
Natural forces (e.g. winds and thermal buoyancy force due to indoor and outdoor air density differences) drive outdoor air through purpose-built, building envelope openings. Purpose-built openings include windows, doors, solar chimneys, wind towers and trickle ventilators. This natural ventilation of buildings depends on climate, building design and human behavior.

B. Mechanical ventilation:

Mechanical fans drive mechanical ventilation. Fans can either be installed directly in windows or walls, or installed in air ducts for supplying air into, or exhausting air from, a room. types of mechanical ventilation used depends on climate.



Proper ventilation helps keep a home energy-efficient, safe, and healthy.



Controlled ventilation from a fan

Natural ventilation

Fig 1: ventilation systems

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. list down the Benefits of good ventilation systems? (3pts)
2. What are the General requirements of ventilation? (3pts)
3. Define what ventilation means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

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Information Sheet-5	Inspecting and preparing work area and equipment

5.1 Mine Work plan:

A work plan is a document that needs to:

5.2 describe the nature and scale of the proposed extractive industry activities

5.3 Identify and assess all risks the extractive industry may pose to the environment, to the public, or to nearby land, property or infrastructure (known as a 'mining hazard')

5.4 include a risk management plan that specifies the measures the proponent will use to eliminate or minimize identified risks and monitor performance

5.5 include a community engagement plan

5.6 Include a rehabilitation plan.

5.7, Site preparation:

- Use existing access tracks where available.
- Where new tracks or turning areas are planned, choose the location with the minimum impact and do not excavate below existing surface levels or remove vegetation.
- Locate stockpile and screening areas where they will:
- Establish stockpiles on the existing ground surface with no excavation below ground surface.

5.8 Working condition:

Before initial operation on production runs, a careful and detailed inspection of the plant, and all of its components, should be conducted.

A Check the alignment of all mechanical components.

B Check the operating alignment of the belts on the carrying rollers and the return idlers. Visually inspect the belts for defective splices.

C Be sure that all moving parts have guards in place.

D Check that there are no mining materials, tools, or projecting members that can rub, tear, or cut the belt when it is started.

E Be sure that chute skirt boards are intact, and are not touching the belt. Adjust rubber edging strips on skirt boards, so that they touch lightly on the belt surface. Adjust belt scrapers, if necessary.

Fig2: Mine equipment and machinery

5.3.1 Ore (Element) Transportation:-

Many factors affect the design of ore transportation systems. Gravity is very important. Ore movement should be designed to minimize flow horizontal or upward flow. Ore passes are successfully in many mines for in-mine ore transportation. Additionally, processing units should be close to each other. Ore transportation typically involves use of chutes. Wall slope is critical to chute design. For example, dry ore and moist/wet ore have different requirements for chute wall slope since their material flow properties are very different. While very steep angles help material flow, they make the ore difficult to control.

Belts: In any modern mine, the most important component of ore transportation is the conveyor belt.

Fig 3: Belt conveyor (ore transporting from mine=>processing)

These can carry thousands of tons of material per hour, and for long distances. They can even negotiate steep angles. Some important features of conveyor belts are:

Idlers: Idlers are used to increase belt carrying capacities, both by providing support and by forming a trough and increasing the volume.

Drive Pulley: These are used to provide motion to the belt. However, since typically more than 180 degree of contact is required between the belt and the pulley for the belt to move and not slip,

Automation: Belts rarely work alone; typically they are part of a belt system. Therefore, their operation is often linked in a way to facilitate material flow and accommodate belt stoppages. Before a belt is stopped, all belts upstream of it are stopped first, so that material does not overflow. Belts also have various safety

components such as emergency stopping based on health (of the belt motors) and safety (of humans).

Self-Check -6	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 What is the difference between Idler ?(3pts)

2 List down some of the Mine Work plan. (3pts)

3 Define what does belt conveyor mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-7	Selecting auxiliary equipment

7.1 Introduction:

As mining is essentially the process of moving product, most quarries inevitably have some form of conveying system crushing and sizing systems as conveyors, crushers and sizes are a very efficient way of moving material. To move large amounts of material requires a lot of energy, and it is this energy, moving parts and nip-points that make conveying, crushing and sizing some of the most dangerous items of plant in a quarry. There are many different hazards that exist around conveyor belts (for example dust, noise, rotating/moving parts). Most of the accidents associated with these activities occur during maintenance operations or when something abnormal has occurred with the process such as a blocked crusher or a spillage of material.

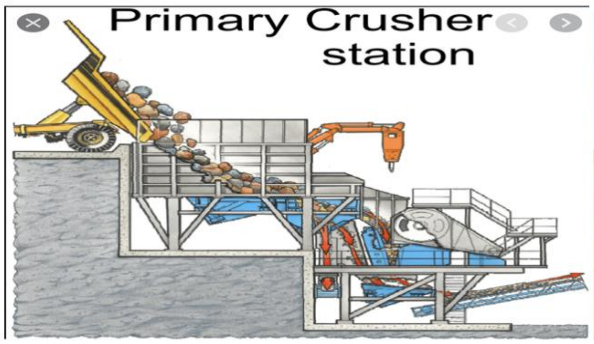
7.2 Auxiliary equipment:

Auxiliary operations include storing conveying, sampling, weighing etc. In surface mining, the primary auxiliary operations include

- ✓ slope stability,
- ✓ pumping,
- ✓ power supply,
- ✓ maintenance,
- ✓ waste disposal, and
- ✓ Supply of material to the production centers.

- **Crushing plants** make use of a large range of equipment, such as a pre-screener, loading conveyor, intake hopper, magnetic separator, crushing unit, such as jaw crushers and cone crusher etc. These are the machines where the

rocks and stones are crushed. There are different types of crushers for different types of rocks and stones and different sizes of the input and output material. Each plant would incorporate one or several crushing machines depending on the required final material (small stones or sand).



appropriate gloves to handle broken glass, or use forceps, tongs, or a dustpan and brush to clean up pieces of broken glass

- **Vibrating Screen**: These machines are used to separate the different sizes of the material obtained by the crushers.
- **Belt Conveyor**: These elements are the belts used for transportation of the material from one machine to another during different phases of process.
- **Central electric control system**: Control and monitor the operation of the entire system.

a. Jack hammer:

Jackhammer is a pneumatic or electro-mechanical tool that combines a hammer directly with a chisel. They are typically used to break up rock, pavement, and concrete. The effectiveness of the jackhammer is dependent on how much force is applied to the tool. It is generally used like a hammer to break the hard surface or rock in construction works and it is not considered under earth moving equipment, along with its accessories (i.e., pusher leg, lubricator).

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An excavator-mounted hydraulic jackhammer being used to break up concrete.

Boulder Buster:

The Boulder Buster is a compact and portable piece of standby equipment that provides a cost-effective and convenient way to safely break rocks and concrete in situations where conventional explosives are prohibited or inappropriate.

Fig: Boulder Buster

- **Additional Equipment**

Other equipment items in crushing circuits can include:

- Rock breaker
- Apron feeder to the primary crusher
- Overhead crane
- Dust collection/suppression system
- Freight elevator
- Eccentric trolley removal cart
- Service air compressor
- Man-lift elevator
- Sump pumps
- Air cannons
- Air vacuum clean up systems
- Water booster pumps
- Rock grapple
- Service trolleys
- Conveyor belt magnets
- Conveyor gravity take-up service winch
- Conveyor belt metal detectors
- Conveyor belt rip detector
- Belt monitoring systems
- Conveyor belt weigh scales
- Belt feeders
- Vibratory feeders
- Screw feeders
- Lime/cement silos
- Bin ventilators
- Sampling stations.

Self-Check -7	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the importance of auxiliary equipment?(3pts)
2. Mention some of the Additional and Optional Equipment.(3pts)
3. Define what auxiliary equipment means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-8	Resolving coordination requirements

8.1 Coordination requirements:

A precondition for the successful implementation of coordination and cooperation is to agree (formally or informally) among programmes on the issues to be addressed and how to tackle them, as well as on the commitments per programme (allocation of time, human and financial resources). Jointly preparing and agreeing on a common action plan would be recommended for structured coordination. Having a clear mandate from each programme representative is important in order to allow real and practical exchanges and harmonization to happen.

Importance of coordination in crushing

The primary objective of interagency coordination is to improve the efficiency and effectiveness of humanitarian response so that the response meets the needs of the affected population to the maximum extent possible. Ultimately, interagency coordination seeks to facilitate efforts, harmonize actions and optimize the use of resources (time, money and personnel) in order to maximize the positive impact for the affected population. Successful interagency coordination leads to improved and more frequent communication and information exchange among participating agencies.

- simplifying and harmonizing procedures by applying the same rules, templates and procedures will bring a benefit for the applicant/ beneficiary
- learning from others and getting new ideas
- sharing programmes' resources: saving efforts and resources (time, human, financial)
- potential for promoting good programme practices

- good contacts among programme bodies that would encourage further joint (content) events
- shared responsibilities and tasks, in case an action plan is agreed

Coordination with others May include with:

- mine persons
- laboratory personnel
- mobile plant operators
- maintenance personnel
- mine supervisor
- Mines Manager
- Site Controller (Fore man)
- Incident Controller (Mate)
- Personnel/Administrative Manager
- Communication Officer
- Fire and Security Officer
- Transport Coordinator
- Medical Coordinator (Common)
- Communication Coordinator (Common)

8.2 Operator training:

Operators are responsible for managing the process in order to obtain a stable production of high quality products and high throughput. The operator's capability in making fast and effective decisions is therefore important. Operator training is often a manual process which is conducted by verbal interaction between an experienced operator and an inexperienced operator. The operators' cognitive ability in detecting and analyzing information from the process can therefore be limited for a novice operator. By performing operator training, the operators' capability in reacting to changes in the process increases and becomes more effective. With an operator training simulator the operator is able to interact with the process without risking any potential damage to the actual equipment, thus providing the operator with valuable hands-on experience.

Training and supervision:

- Provide supervision – ensure that safe work procedures are followed
- Tell workers about the hazards associated with their work.
- Provide workers with training on: n working safely with hazardous substances; when and how to use controls; how to check they are working; and what to do if something goes wrong.
- Consider keeping training records.
- Involve managers and supervisors in health and safety training.

Figure 1: The simulation computer running a plant simulation while information is being transferred to the operator's screen.

Self-Check -8	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements for Coordination? (3pts)
2. What is the responsibility of mine Operators? (3pts)
3. List some of the Coordination with others. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

LG #37	LO #2- Operate the crushing plant
Instruction sheet	

This learning guide is developed to provide *yo*u the necessary information regarding the following content coverage and topics

- Crushers and crushing principle
- Carrying out pre-start, start-up, run and shutdown procedures
- Selecting and modifying operating technique
- Using dust suppression and extraction methods
- Conducting, controlling and monitoring crushing operations
- Acting on or reporting performance monitoring systems and alarms
- Recognizing and responding to hazardous and emergency situations
- Completing work

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Crushers and crushing principle
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Information Sheet-1	**Crushers and crushing principle**

1.1 Crushing operation:

Crushers are the first mechanical stage in the commination process. Crushing is generally performed in a two or three stage process. The crusher's main purpose is to reduce the size of raw quarry material or shot rock into usable aggregate. The size requirement of the primary crusher is a function of grizzly openings, ore chute configuration, required throughput, ore moisture, and other factors. Usually, primary crushers are sized by the ability to accept the largest expected ore fragment. Jaw crushers are usually preferred as primary crushers in small installations due to inherent mechanical simplicity and ease of operation of these machines. Additionally, jaw crushers wearing parts are relatively uncomplicated castings and tend to cost less per unit weight of metal than more complicated gyratory crusher castings.

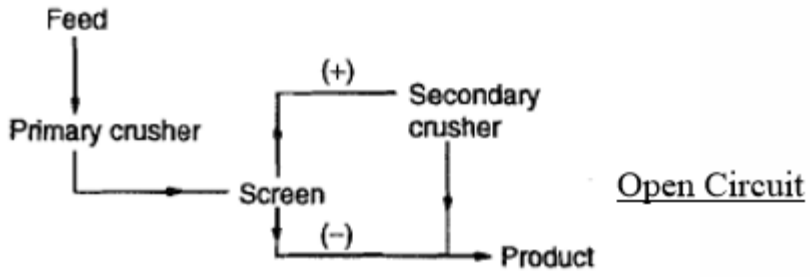


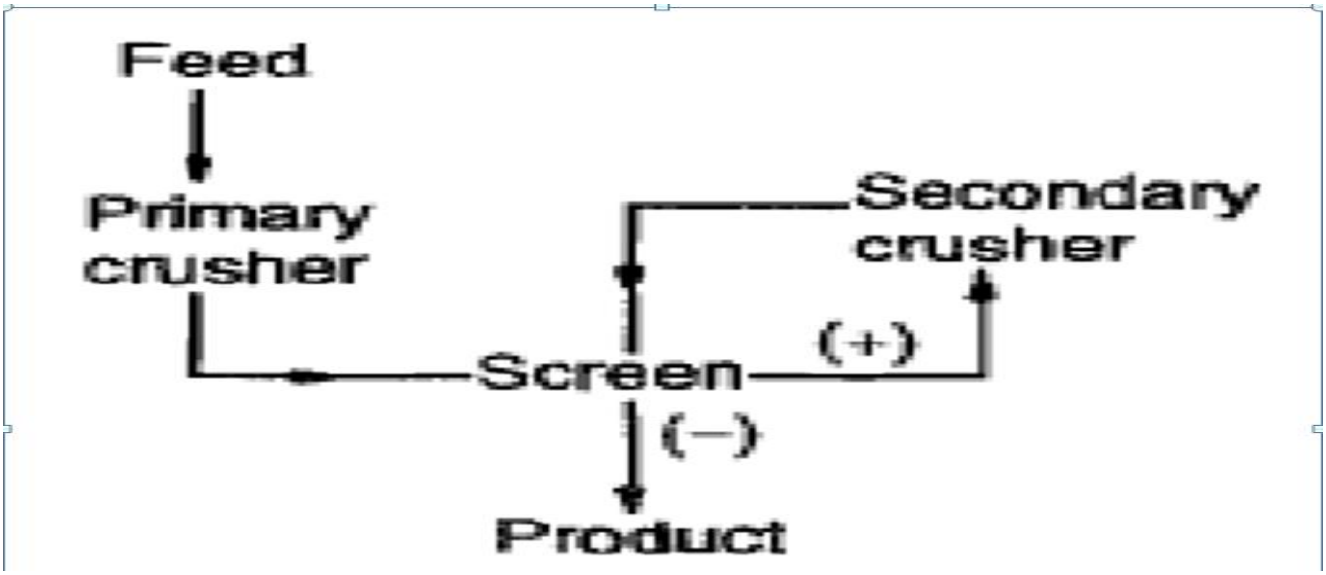
Fig 1: Open circuit

Crushing is done in **closed circuit**, when crusher flexibility is desired. Here, the product is screened with the undersize moving to the next stage, but the oversize being sent back to the crusher.

Fig 1: crushing in mine plant

Crushing is done in open circuit or closed. Both have their applications. When done in **open circuit,** the product goes to the next stage in commination (typically a rod mill). Since the product is not screened, the next stage needs to be able to accommodate size fluctuations.

Crushing is done in **closed circuit**, when crusher flexibility is desired. Here, the product is screened with the undersize moving to the next stage, but the oversize being sent back to the crusher.



Closed circuit

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the difference between open and closed circuit operation?(3pts)
2. What is the importance of crushing in mine operation? .(3pts)
3. Define what does crushing mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	**Carrying out pre-start, start-up, run and shutdown procedures**

2.1 Introduction:

In mining operations, the layout of crushing plants and ancillary equipment and structures is a crucial factor in meeting production requirements while keeping capital and operational costs to a minimum. The critical design parameters as well as the consideration of ore characteristics, geographical location, climatic conditions, expected operational life, expansion potential, safety, environment, and operability and maintainability. There are three main steps in designing a good crushing plant: process design, equipment selection, and layout. The first two are dictated by production requirements and design parameters, but the layout can reflect the input, preferences and operational experience of a number of parties. These can include the owner's engineering staff, safety personnel, operations and maintenance personnel, equipment manufacturers, and the engineering consultant. Ideally, the consultant combines his knowledge and experience with an understanding of all parties' needs, to provide a balanced, workable, safe and economic plant design.

Fig 1: Steps in mining processes

2.2 Design parameters:

2.2.1 Production Requirements:

The process design criteria define the project's production requirements, and typically include those shown in figure1.

Process Description	General Ore Characteristics	Operating Schedule
General	Maximum rock size in the feed	Days per year
Primary crushing	Ore types, compressive strengths	Hours per day
Fines crushing	and abrasion indices	Nominal annual throughput
Storage & reclaim	Ore specific gravity	Mining shifts per day
	Ore bulk density	Crushing plant shifts per day
	Ore moisture, wet season	System availability and
	Ore moisture, dry season	utilization
	Angle of repose	
	Angle of withdrawal	
	Angle of surcharge	

2.3 Process design criteria:

The information required to develop crusher process design criteria includes:

- ✓ Geographic data
- ✓ Climatic data
- ✓ Civil design criteria
- ✓ Structural design criteria
- ✓ Process design data (process description, ore characteristics)
- ✓ Mechanical design criteria

Electrical/instrumentation design criteria

Fig 1: crushing operation

The following are some of the objectives of commination:

- Reduction of large lumps into small pieces.
- Production of solids of desired size range.
- Liberation of valuable minerals from gangue minerals.
- Preparation of feed material for different beneficiation operations.
- Increasing the surface area for chemical reaction.
- Convenience in handling and transportation.

The energy consumed for the commination operation is high when compared to other operations such as screening, beneficiation, dewatering, conveying etc. in Mineral and Mining Industries. Hence attention needs to be paid to minimize the production of fines (finer than required) which will consume additional power for reducing to fines.

2.4 Mine Plant shut-down:

- For the job of plant shut-down, describes basic job steps, potential accidents and hazards, and recommended safe job procedures. The job of plant shut-down is usually done by the plant operator, but may be done by other occupations, such as utility worker, laborer, etc. The plant operator/utility worker must make sure that employees, and others, are protected from accidents and injuries that could result from plant shut-down operations.
- Remember to observe two key precautions during normal plant shut-down:
- 1. Do not shut off any equipment that is still carrying material.
- 2. Do not shut off any equipment to which material is still being delivered. **Note** that these precautions only apply to normal shut-down procedures. They do not apply to emergency situations.

- Material left on, or in, equipment can cause problems during start-up. For example, attempting to start a loaded conveyor belt can cause slippage at the drive pulley, or motor overload. If equipment is shut-off while material is still being delivered to it, a pile-up of spilled material will occur at the transfer points. An improper shut-down sequence can damage plant equipment, and can also increase the risk of injury, if extensive clean-up is required. For proper, normal shut-down, the feed of material into the plant must be stopped first, if sequence rollers are not in use. The rest of the shut-down procedure must then wait until the plant is clear of material or at least until each piece of equipment is clear of material. The various plant equipment is generally shutoff in the same order as the material flow, starting with the primary feed system - pit material input - and working through the finished product conveyors. The fresh water pumps, sand pumps, and other pumps are shut off last.

Fig 3: plant shut-down

Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the parameters to design crushing plant operation?(3pts)
2. Mention some of the objectives of commination.(3pts)
3. Define what a commination means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Selecting and modifying operating technique

3.1 Crushing Equipment:

Crushing equipment is used to crush rock and stone. Designed to achieve maximum productivity and high reduction rate, mining crushing equipment can come in a variety of different types for a range of jobs. Crushing equipment is specially configured to break down the hard rock matter or gravel to a manageable size for transportation or conveying. Crushing equipment is important to the mining process because it reduces the use of precious excavated resources and eliminates the amount of material on site. The presence of a screen allows the crusher to be used on any size setting at a given time, with the screen (one or multiple) making the final product selection.

Equipment selection:

Crusher Types, the choice of crusher depends on the type and amount of material to be crushed

- The selection of the right crushing equipment is influenced by many factors some of which are upstream of the crushing plant (e.g. blasting pattern and mining method) and others which are downstream of the crushing plant (e.g. mill and grinding circuit selection).
- Crushers have more efficient transfer of applied power to the breakage of rock than grinding mills.
- Typically a crushing flow sheet for a mineral processing plant will have from one-to-three stages of crushing. There are some cases where the process requires a fine dry product and a quaternary stage of crushing will also be included.

As the crushing is performed in stages, crushing may be divided into:

1. **Primary Crushers:** Jaw crusher, Gyratory crusher.

2. **Secondary Crushers**: Reduction gyratory, Cone crusher, Rolls crusher.
3. **Tertiary Crushers**: Short-head cone crusher.
4. **Fine Crushers:** Impact crushers.
5. **Special Crushers**: Bradford Breaker, Toothed Roll crusher.

- **Primary Unit:**

The primary unit is made up of multiple sections. The major equipment in a primary crushing circuit usually includes only a crusher, feeder and conveyor. The first section is the vibrating grizzly screen. The vibrating grizzly is a series of bars set on top of the hopper that vibrate, separating the stone into different sizes and then sending it to the hopper; if the stone is too big, it will not be allowed to pass and enter the hopper. The hopper arranges the raw material before feeding it to the crusher. The crusher will then reduce the material and drop it onto conveyors, which take the stone and transport it to the secondary unit. The purpose of the primary crusher is to reduce the ROM ore to a size amenable for feeding the secondary crusher or the SAG mill grinding circuit.

- Typical rules for primary crusher selection:
  - **Rule 1:** Always use a jaw crusher if you can due to lower costs.
  - **Rule 2:** For low capacity applications, use jaw crusher and hydraulic hammer for oversize.
  - **Rule 3:** For high capacities, use jaw crusher with big intake openings.
  - **Rule 4:** For very high capacities, use gyratory crusher.

Fig 1: primary unit

The raw mined material is brought to the crusher plant by rear-dump haulers or frontend loaders. Primary crushing reduces this run of mine rock to a more manageable size. The two types of primary crushers are the compression (jaw crushers and rollers) and the impact crushers (Hammer Mill).

The jaw crusher compresses rock between two V-shaped surfaces; one is stationary and the other opens and closes like a jaw. The opening and closing action of the movable jaw against the fixed jaw continues to reduce the size of the lodged pieces of rock until the pieces are small enough to fall through the opening at the bottom of the jaw. The jaw crusher can be powered by a diesel engine or by electrical power.

The different types of primary crushers are: jaw crushers, gyratory crushers, impact crushers.

a. Jaw crusher:

The jaw crusher squeezes rock between two surfaces, one of which opens and closes like a jaw. Rock enters the jaw crusher from the top. Pieces of rock, that are larger than the opening at the bottom of the jaw, lodge between the two metal plates of the jaw. The opening and closing action of the movable jaw against the fixed jaw continues to reduce the size of lodged pieces of rock until the pieces are small enough to fall through the opening at the bottom of the jaw. A jaw crusher is the compression kind of crusher and used for crushing rock between two heavy steel jaws. The movable jaw compresses the

material against the fixed jaw and crushes material at the desired size. Material exits from the bottom of jaws.

Characteristics Jaw crusher:

- Crushing occurs between two moving plates that are arranged to form an acute angle to apply a compressive force that results in tensile failure
- Typically preferred for feed rates of 900 TPH or less.
- Can be located underground or surface
- Typically only a primary crusher.
- Operated in open circuit
- The gape and the width are set values for a given crusher while the setting can be altered to adjust the product size.
- They are working little than half the time.
- Because of heavy flywheel and high speed of rotation they are favourable to more efficient action of jaw crushers.
- Have less capacity than gyratory crushers,
- Work in open circuit with double deck screen.

Energy requirements of a jaw crusher.

- ✓ Depend on Size of the feed,
- ✓ Size of the product,
- ✓ Capacity of the crusher,
- ✓ Characteristics of the ore,
- ✓ Percentage idling time.

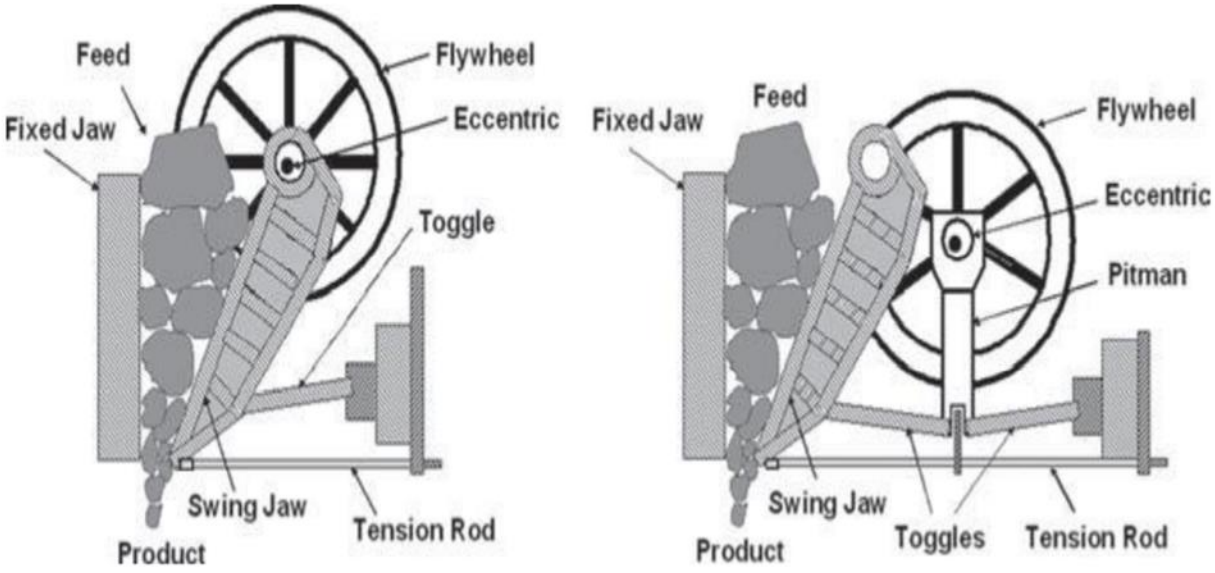


***Figure 6*(a) Single toggle jaw crusher; (b) Double toggle jaw crusher.**

b. Gyratory crusher

A gyratory crusher breaks rock by squeezing the rock between an eccentrically gyrating spindle, which is covered by a wear resistant mantle, and the enclosing concave hopper. As run-of-mine rock enters the top of the gyratory crusher, it becomes wedged and squeezed between the mantle and hopper. Large pieces of ore are broken once, and then fall to a lower position (because they are now smaller) where they are broken again. This process continues until the pieces are small enough to fall through the narrow opening at the bottom of the crusher.

Characteristics of gyratory:

- Capacity is greater than jaw crushers.
- Required power less than jaw crushers.
- There is less vibration in operating.

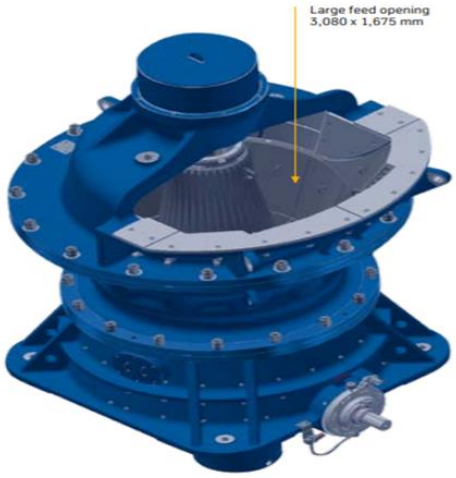


Fig 2: gyratory crusher.

2. Secondary crusher:

a. Cone crusher

b. Roller crusher

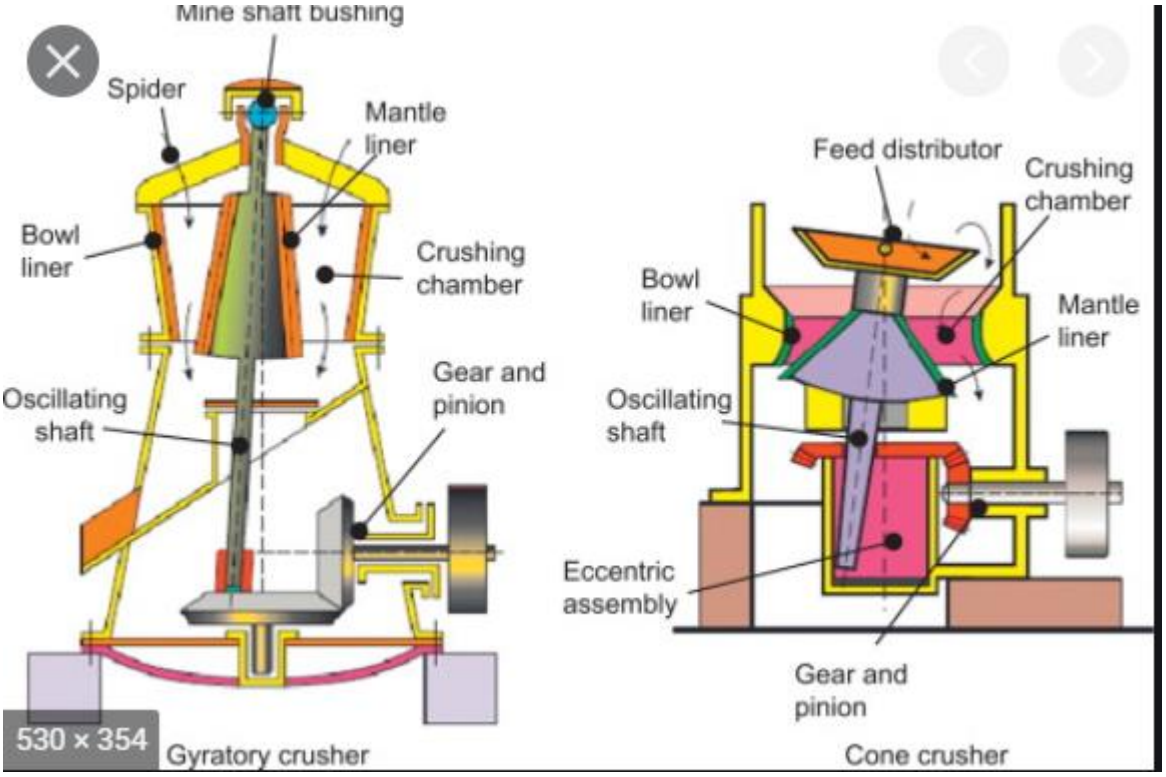
a. Cone crusher;

Cone crushers remain the most popular for fine crushing applications,Cone crushers range in size from 559mm to 3.1 m and have capacities up to 1100 t h -1 with a discharge setting of 19 mm, The throw of cone crushers can be up to five times that of primary crushers, which must withstand heavier working stresses. They are also operated at much higher speeds. The material passing through the crusher is subjected to a series of hammer-like blows rather than being gradually compressed as by the slowly moving head of the gyratory. Cone Crusher also called a gyratory crusher. Cone crusher also a compression kind of machine that reduces, squeezing, or compressing the material between a moving piece of steel and a stationary piece of steel. The material passed it through the bottom of the machine after passed the cavity

Merits of cone crusher over gyratory

- ✓ Cone crusher moves faster than gyratory.
- ✓ Rapid discharge of crushed material due to increase space from top to bottom.

- ✓ Higher capacity and reduction ratio than gyratory crushers.
- ✓ Work in closed circuit



b. Roll crushers:

Roller crusher breaks the material by squeezing it between two revolving metal cylinders that axes parallel to each other and separated according to required results. The rolls may be gear driven, but this limits the distance adjustment between the rolls; and modern rolls are driven by V-belts from separate motors. The distinguished feature of a roll crusher is that the material is crushed one time only whilst it is passing through the crushing chamber.

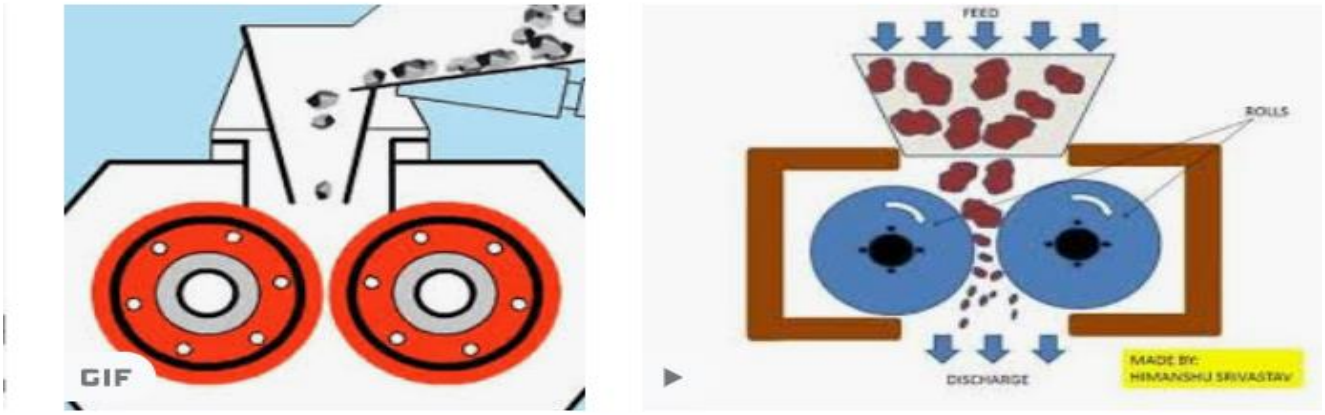


Fig 3: roll crusher

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the rules for primary crusher selection?(3pts)
2. Mention the Characteristics of Jaw crusher.(3pts)
3. What are the parameters for selection crushing Equipment? (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Using dust suppression and extraction methods

4.1 Dust:

Dust will be emitted from roadways, stockpiles, waste areas, vehicles, conveyor belt drop-offs, crushers and classifiers. Emissions can be controlled by wetting, enclosing the process area, reducing drop heights and by the use of air filters. Rock dust may cause lung disease in exposed workers. It is known that high dust concentrations are severely hazardous to health of miners and the safe operations of coal mines.

Fig 1: Water spray

Dust control

Mine health and safety is an integral part of every mining operation of which dust control is an important element. The methods for controlling dust emissions can either lie in the prevention of dust emissions or in the removal of dust once it has become airborne. Water spray systems can be used for both methods of dust control. During the mining phase, aggregate will be washed prior to crushing operations to minimize dust emissions during both the crushing and the sorting/stockpiling phases. **Good plant layout practices include:**

- ✓ separating dusty from non-dusty operations;

- ✓ enclosing dusty machines and transfer points and extracting dust through an exhaust system;
- ✓ reducing the amount of fall of materials at transfer and discharge points with the discharge chute for fine material being sloped rather than perpendicular;
- ✓ using collapsible wind socks (elephant trunks) at the discharge point of stockpile conveyors;
- ✓ preventing chutes becoming empty;
- ✓ providing a dust-free operator's room under positive air pressure;
- ✓ employing good housekeeping methods by cleaning up spillage, paving the environs of the plant or keeping them oiled or damp;
- ✓ reducing the speed of all vehicles near the plant; and
- ✓ Covering dumps with vegetation as soon as practicable, but in the early stages spraying with chemicals to provide a protective coating.

Pay attention to roads throughout the mine work site area by:

- providing paved surfaces where practicable;
- watering roads and tracks whether sealed or not;
- restricting vehicles to defined roads or tracks;
- restricting speed of vehicles; and
- Watering down loads before leaving the loading site.

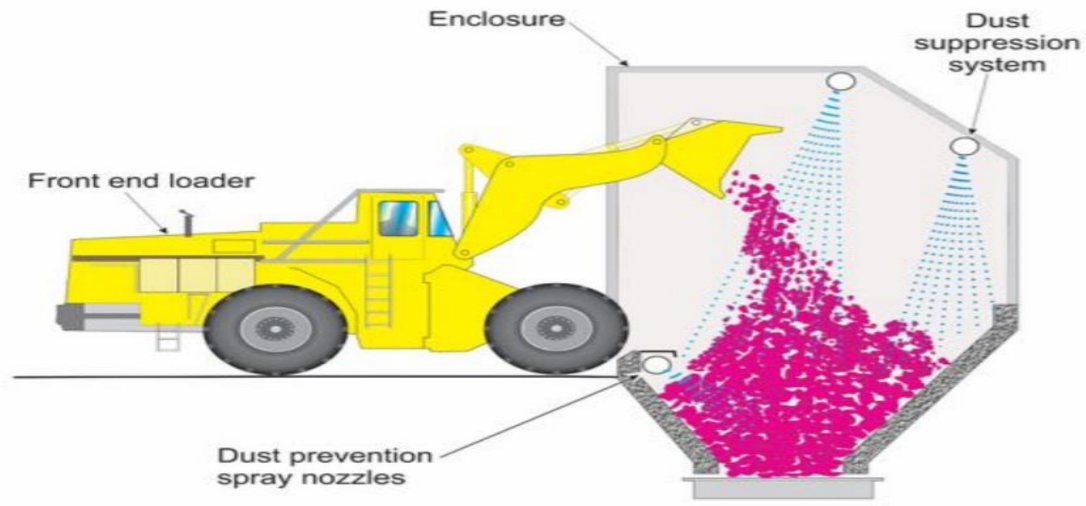


Figure 2: Typical loader dump dust control application.

Some dust mitigation measures include:

- ✓ Minimizing the area of disturbance and progressively vegetating to prevent the generation of dust.
- ✓ Minimizing truck and vehicle movements onsite and on public roads that are often a source of dust.
- ✓ Minimize vehicle movements.
- ✓ Reduce onsite vehicle speeds, especially during dry or windy conditions.
- ✓ Apply water to access tracks to prevent raised dust occurring.
- ✓ Use dust suppressants where watering is not possible or appropriate; oil must not be used as a dust suppressant.
- ✓ Cover or dampen loads leaving a site.
- ✓ proper ventilation of working places, particularly dead ends (for example, by supplying dust-free air to the face);
- ✓ wetting muck piles when moving broken rock, loading trucks or dumping into bins or stockpiles;
- ✓ providing wheels or cutting compound of silicon carbide or aluminum oxide instead of sandstone (to reduce the amount of silica in the dust) and water sprays when using grinding wheels, sawing dimension stone or core cutting;

- ✓ use of wetting agents with water in selected processes;
- ✓ use of clear water for sprays and mists; and
- ✓ Use of total wet processes in crushing and screening plants.
- ✓ Stop the crushing plant.
- ✓ Increase use of watering systems.
- ✓ Stop work in some areas of the site.

Fig 3: water spraying operation

Self-Check -4	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements of Good plant layout practices? (3pts)
2. Mention some of the dust mitigation measures. (3pts)
3. Define what does mine dust mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	**Conducting, controlling and monitoring crushing operations**

5.1 Conducting Crushing operation

The Crusher Supervisor must be involved in the planning of the crusher operations from the very beginning. As supervisor, your input will help shape all crusher operations. You need to be able to evaluate the job site and pick the best placement for the plant, one that minimizes haul time for raw materials yet is far enough away from the blasting operations to keep the crew safe. The plant location needs to include the placement of a retaining wall or ramp for use as the discharge platform for the hopper-loading

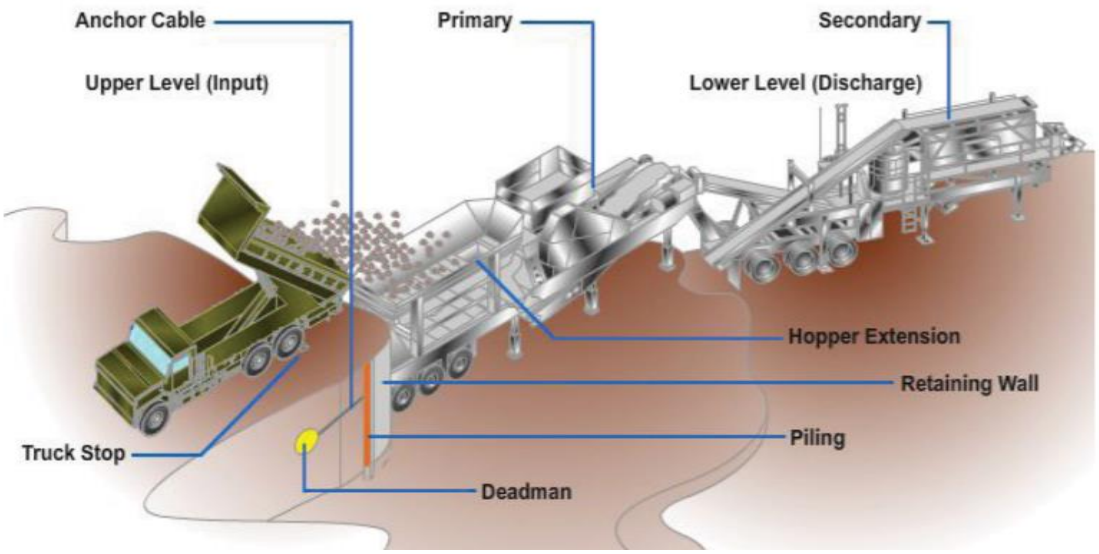


Fig 1: Crusher lay out equipment in dual level operation

5.2 Pre Conditions for crushers:

Machine-specific condition monitoring focuses on vibrating components in crushers and screens such as drive shaft bearings, safety plate wearing and

gears. The low, middle and high frequencies of monitored components are measured and supervised in real-time to detect abnormalities due to slow or fast wear, looseness or imbalance. The condition monitoring enables efficient and predictive maintenance saving the crushing plant from component breaks and resulted maintenance costs and production losses. Intelligent control and monitoring of feed into crushing/screening operations can increase throughput and product quality whilst improving operator occupational health, safety and

Wellbeing Latest-generation control of a complete crushing and screening plant can now readily be conducted remotely from a centralized control room or weighbridge office at a quarry, including any or all of the primary, secondary and tertiary crushing processes. This not only offers opportunities to reduce production costs, but also wider benefits to producers, staff and customers. A good control system will continuously monitor plant performance, for example: reading the rate of passage of material through sections of the plant using beltweighers; measuring the current drawn by crushers and screens; or using level sensors to monitor the contents of surge hoppers or even final storage bins. Not only will this information be continuously provided to the operator, but, crucially, the system will adjust the process automatically, typically controlling the rate of delivery into the plant by changing the speed or extent of vibration of an incoming feeder, to keep these measured flow rates, currents and/or levels at or close to their required settings. This ensures that the plant is automatically kept at its optimum performance, maintaining high throughput whilst minimizing downtime as well as often reducing excessive wear and tear on the plant. A high production rate combined with reliability in the expected output from the plant benefits both producers and their customers, both of whom can have confidence that the ordered loads will arrive with less susceptibility to breakdowns and interruptions. It can also reduce stress on staff to repair and clean up under pressure following a breakdown, and limit friction between management and staff over possible causes.

5.2.1 Mine Operators:

Operators are responsible for keeping the process running. The level and the type of interaction an operator has with the process is determined by a number of factors such as: the level of automation integrated into the process, the size of the plant, the complexity of the process and the operational management. A common reason for operators to shut down the process is due to maintenance. The process and equipment are designed to withstand high load, abrasive material and high vibration. Because of this the process does not require frequent maintenance, except for changing wear parts. Wear on critical components usually affects the process by causing loss of potential production. Regular maintenance of such components is therefore necessary, but too frequent maintenance is not advantageous either, since the cost of new components and downtime has to be less than the potential gain in production profit.

Mine plant operator

The main purposes of crushing are:-

1) Convenience in transport

2) Production: for use without further treatment beyond screening, of graded size and shapes.

3) Liberation of specific Mineral as a step in separate recovery from the ore.

4) Exposure of contained values to chemical attack

5) Production of granular material suitable for treatment by gravity methods.

6) Development of particles suitable for feed to froth flotation, cyanidation and act.

Fig 2 : Crushing operation

Self-Check -5	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down the main purposes of crushing? (3pts)
2. How can monitor crushing operations? (3pts)
3. Define what does crushing mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-6	**Acting on or reporting performance monitoring systems and alarms**

6.1 Monitoring systems and alarms:

Alarm systems are critical assets for operational safety and efficiency of plants in a variety of industrial sectors, such as power and utility, process industry, crushing and screening operation, mineral processing. Driven by the big gap between poor performance of industrial alarm systems and their importance for operational safety and efficiency, rationalization of alarm systems has recently received increasing attention from both industry and academic communities. Automatic alarm analysis is important for network operation. Numerous alarms from different layers of a network may be caused by one single fault finding the correct causal direction between two sets of correlated alarms helps to locate the original fault correctly. Causal direction inference can be taken as a task of feature extraction

Each day the Quarry Manager will carry out a number of checks and inspections of the quarry equipment and the quarry site. These will include:

- Integrity of the site.
- Prestart plant checks.
- Plant and equipment operating hours.
- Health & safety issues eg PPE, proper access & storage of hazardous substances etc

Potential environmental effects eg noise, dust, water and sediment controls. The plant related information will be recorded on a standard plant sheet while the other inspections will be recorded on the Daily Monitoring Record. The Quarry Manager should take corrective action upon identifying an issue and record the action taken (or still required to be taken) on the form.

b. Wear:

The crushing process is constantly affected by wear which causes gradual performance deterioration. How the wear affects the process is dependent on multiple factors. These include the characteristics of the equipment subjected to wear, the geometry of affected components and the properties of the rock material: mineral content, particle size distribution, moisture and more.

c. Fire/explosion:

Action in the event of a fire should be, if possible, attempt to prevent small fires from developing into larger ones. All electrical fires must be extinguished with dry powder or co2 If you are attempting to control a fire ensure some other staff member carries out the fire procedure as given below. They should:

- ✓ Raise the alarm immediately, warn any nearby personnel and (if functional) operate the nearest fire alarm.
- ✓ Ensure that the fire service (if available) is notified. Clearly state the location and nature of the emergency.
- ✓ Potentially dangerous machinery and fuel sources should be shut down if it is safe to do so. Leave lights on.
- ✓ Leave immediately by the nearest safe exit route. Move quickly but DO NOT RUN.
- ✓ Report to the designated assembly point.
- ✓ Stay at the assembly point until the “All Clear” is given by the Safety Officer.
- ✓ Only if it is safe to do so should any attempt to fight the fire be made.
- ✓ do not attempt to put out a fire if it involves personal risk

Fig 1: over all mine plant Operate

Self-Check -6	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the importance of Alarm system? (3pts)
2. Mention the procedures of Alarm system. (3pts)
3. Define what does Alarm systems mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-7	**Recognizing and responding to hazardous and emergency situations**

7.1 Hazards:

Crushing accidents occur when the body or any part of the body is squeezed between two moving objects or caught between one moving and one stationary object. Minor crushing accidents can cost workers in many ways, in pain, disability, and the loss of a job. Major crushing accidents can even cost a life. Workers must always be aware of where they are in relation to moving equipment around them. Machinery, equipment, appliances or tools that can be generically grouped as 'plant' are everywhere in most workplaces. While many hazards are associated with such plant, on the hazards associated with the moving parts of machinery, which have the potential to cause injury by crushing, shearing, entangling, trapping, hitting or abrading, or through the uncontrolled release of pressure. Control strategies for these hazards have evolved from the simple approach of fencing in dangerous machine parts to a more sophisticated systematic approach involving: elimination or minimization of the risk through design; engineering controls to prevent access to hazardous zones or to protect workers who have to access hazardous zones; administrative controls, including provision of information, training and instruction; and procedural approaches, such as Permit To Work and lockout/tag out systems. In developing or monitoring such controls, the generalist Occupational Health and Safety (OHS) professional must remain aware of the ways such protections can be defeated or break down. Rushing plant Crushing hazards:

Common hazards that can be eliminated through design include:

- **Mechanical hazards:** Hazards made by the shape, relative location, mass and stability, movement and strength of machine parts.

- **Electrical hazards:** Contact with or distance from live parts, suitability of insulation, static electricity, heat radiation and results of overloads or short circuits. High voltage electrical supplies may be required to operate machinery such as crushers, conveyors and screening equipment.
- **Heat hazards:** Contact with high- temperature objects or materials.
- **Radiation hazards:** Both ionizing, for example x-rays and gamma rays, and non-ionizing, for example electric and magnetic fields, radio waves, microwaves, infrared, and ultraviolet radiation.
- **Ergonomic hazards:** Poor machine set-up leading to injuries and operational errors.
- **Maintenance hazards:** When guarding is removed or switched off for cleaning, maintenance or access to the area around a machine.
- **Slips, trips and falls hazards:** Flooring surface and access.
- **Work environment hazards:** Environmental conditions,
- **Collision:** This often takes the form of people being hit by vehicles or moving, flying or falling objects.
- **Manual Handling:** Many injuries are associated with handling, lifting and carrying heavy or unconventional shaped objects.
- **Trips and falls:** Slips, trips and falls are regular occurrences in mine industry and result in many injuries. Typically, these are because of uneven ground and poor housekeeping.
- **Loud noise:** a noise survey should be carried out to identify areas and equipment where noise levels exceed 85 DB(A) over an 8-hour period and 140 dB peak. Regulations require all practicable steps to be taken to prevent exposure to noise above these levels and in areas where it is not practicable to reduce it, warnings should be posted up and suitable hearing protection provided. Supervision to ensure the protection equipment in used and maintained should be in place. Plant operators are most at risk and soundproofed operator cabins may be necessary to maintain safe exposure levels.

- **Dust:** Dust is another widespread significant hazard in crushing and screening plants. Airborne rock dust can cause serious lung disease, as well as giving rise to visibility and environmental problems. Lung diseases are caused by very fine particles known as respirable dust that penetrate deep into the lung. Elimination and isolation of harmful dust by engineering and administrative controls should be the first priority and only where there is no practicable solution should respiratory protection masks become the method of minimizing harm.
- **Vibration:** vibration may cause dangerous situations to develop in the form of broken welds and loose bolts but the vibration itself can also be a serious health hazard. Noise and vibration are usually connected so where there is loud noise there is likely to be a vibration hazard as well. Unexpected or excessive vibration may be an indication of an instability problem, particularly on a portable plant.

Plant operators exposed to intense long-term vibration are at risk of developing chronic back pain and other complaints due to whole-body vibration. Vibration is generally transmitted to the body from crushing and screening plant surfaces through the feet or through seats. The structure of operating areas should be designed to minimize vibration.

- **Falling Objects**:

Falling Objects, overflow from plant items such as hoppers, crushers and conveyors is a potential hazard and so are rocks (and other objects) that may fall from elevated platforms, mobile plant and

Stockpiles: Plant and stockpiles should be designed and constructed to eliminate the problem as far as practicable.

- **Flying rock chips** :

Flying rock chips are a potential hazard in many parts of the crushing and screening plant and should also be eliminated or isolated by engineering design where possible.

Precautions may include:

a. selecting plant designed to minimize this hazard.

b. Providing operator protection by enclosed cabins and/or other barriers.

c. Ensuring appropriate personal protective equipment is used – in particular eye protection.

d. Post up and maintain clear warnings at all hazardous areas.

Safety Precautions:

The list below outlines ways of reducing the risk of a crush-point incident.

- ✓ Identify machines that may have crush points.
- ✓ Do not allow anyone to stand or place any body parts in the space between two objects that form a crush point.
- ✓ When hitching an implement, wait until the tractor has completely stopped before approaching the hitch point.
- ✓ If possible, hitch a tractor and implement by backing the tractor into position without having a person positioned between the tractor and the implement.
- ✓ As a backup in case of a mechanical failure such as a jack slipping or an overhead support breaking, use blocks to secure any equipment before working under it.
- ✓ Block the wheels of an implement to prevent the implement from rolling.
- ✓ shutdown the machinery and equipment
- ✓ identify all energy sources and other hazards
- ✓ identify all isolation points
- ✓ isolate all energy sources
- ✓ de-energize all stored energies
- ✓ lockout all isolation points
- ✓ tag machinery controls, energy sources and other hazards

- ✓ Test by ‘trying’ to reactivate the plant without exposing the tester or others to risk (failure to reactivate ensures that isolation procedures are effective and all stored energies have been dissipated).

Self-Check -7	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements of mine hazard?(3pts)
2. Mention some of the Common hazards that can be eliminated through design.(3pts)
3. Define what mine hazard means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

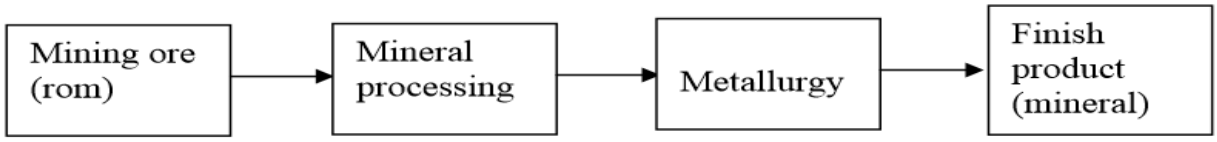
Name: _____ Date: _____

Short Answer Questions

Information Sheet-8	Completing work

8.1 Ore Transportation:

Many factors affect the design of ore transportation systems. Gravity is very important. Ore movement should be designed to minimize flow horizontal or upward flow. Ore passes are successfully in many mines for in-mine ore transportation. Additionally, processing units should be close to each other. Ore transportation typically involves use of chutes. Wall slope is critical to chute design. For example, dry ore and moist/wet ore have different requirements for chute wall slope since their material flow properties are very different. While very steep angles help material flow, they make the ore difficult to control .Mineral preparation is that step in mining (a series of steps, actually) that converts the run of mine ore (i.e. ore as mined in its raw form) into an enriched product, one that is significantly closer to the desired final mineral/metal, than the ore. It is called mineral preparation because it prepares the rom ore so that it is ready for the mineral extraction methods (metallurgy). Of course, not all rom minerals require mineral preparation or metallurgy. Very rich iron ore, sand and gravel and (some) coal are example of minerals that do not necessarily undergo any beneficiation prior to their use.



An important achievement during the mineral preparation stage is reduction in the amount of rock that needs to undergo metallurgy. A significant precent of waste rock is eliminated; with the exact amount dependent on ore geology. Reduction in amount not only makes metallurgy more effective, it also reduces a variety of costs including transportation, supplies and facilities.

The various consequences of mineral preparation are:

i. reduction in volume of ore
ii. separation of the different types of minerals for poly-metal ore, so that each may follow a separate preparation process, if necessary
iii. losses in the various sub-processes such as concentration

Mineral preparation consists of liberation and separation/concentration. Liberation involves exposing the mineral values from within the rock so that they can be extracted. This is achieved by crushing and/or grinding. This reduces the waste rock to somewhat distinct particles of waste and valuable mineral. In the next stage, these particles are separated by physical (using properties such as specific gravity) or chemical means into valuables (concentrate) and waste (tailings).

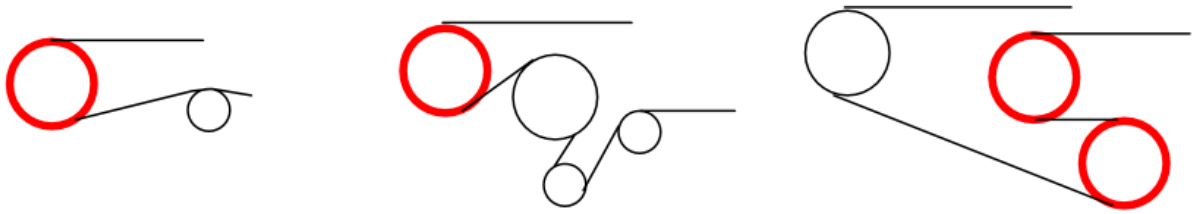
. Thus while liberation is primarily a physical process, separation/concentration can be either a physical process or a chemical process. There is actually another part to mineral preparation, a part that deals with finishing up and involves processes such as dewatering, transportation and disposing of the tailings.

Fig 1: Ore transportation

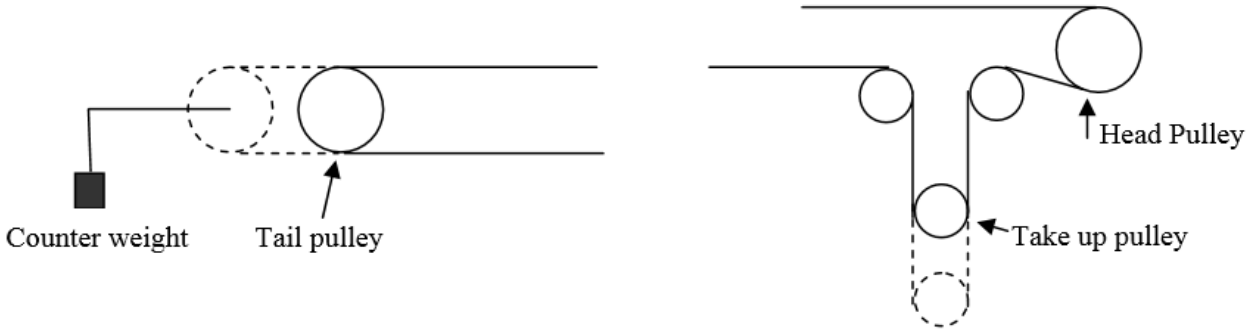
Belts: In any modern mine, the most important component of ore transportation is the conveyor belt. These can carry thousands of tons of material per hour, and for long distances. They can even negotiate steep angles. Some important features of conveyor belts are:

Idlers: Idlers are used to increase belt carrying capacities, both by providing support and by forming a trough and increasing the volume.

Drive Pulley: These are used to provide motion to the belt. However, since typically more than 180 degree of contact is required between the belt and the pulley for the belt to move and not slip, other pulleys are used in conjunction with the drive pulley (in thick red lines in the figure below).



T**ensioning**: Belt lengths change from usage or improper maintenance. Therefore, tensioning devices are used so that pulley-belt contact is strong enough for the load capacity and for preventing sag in the belt. Hydraulic or gravity systems are common.



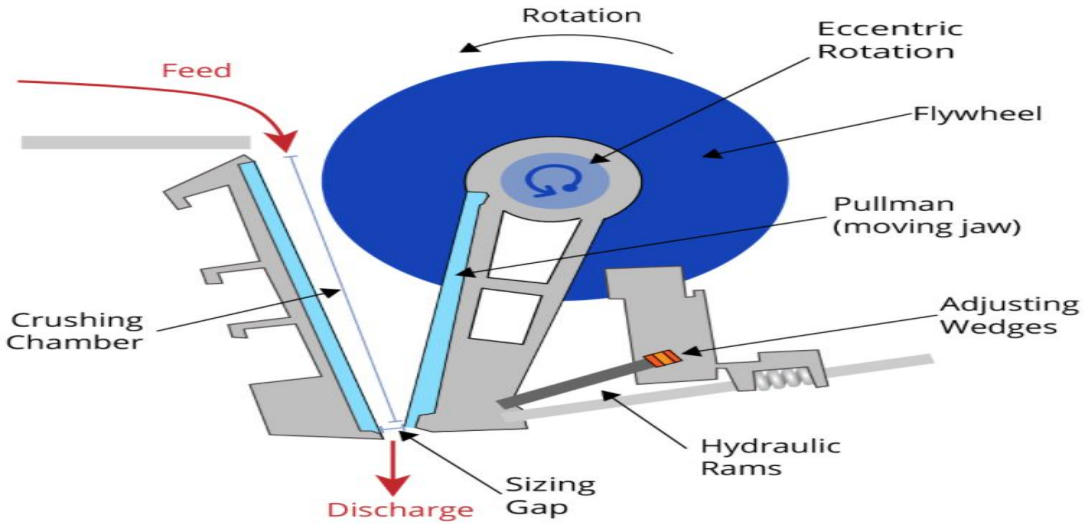


Fig 2: Crushing machine.

Material Handling Technologies used in Crushing Units

Various types of material handling technologies are used in the stone crushing industry for the purpose of moving the stones from one equipment to other, right from the point of raw material unloading up to stockpiles of products. Primarily, feeders and conveyors are used in almost all crushers, which are briefly described below.

a. **Feeders**

Feeder is used for conveying raw, mined stones from the stone well to the Primary Crusher. Feeder movement is controlled by electrically operated switch.

Some of the common feeders in use are apron, belt and vibratory type feeders, which are briefly described below.

• **Apron feeder**: This type consists of uniform overlapping pans attached on to chains or joined by integral links to form an endless conveying medium that travels over supported rollers. The underside of these pans is reinforced to withstand impact and pressure.

• **Belt feeders**: Belt feeders can handle a wide range of materials including sand, gravel, crushed stone, crushed rock, and other bulk materials.

• **Vibratory feeders**: This type vibrates at relatively high frequency and small amplitude

Self-Check -8	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements of crushing operation?(3pts)
2. Mention the Some of the common feeders.(3pts)
3. Define what feeder means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

LG #38	LO #3 operate the screening plant

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Resolving coordination requirements
- Carrying out pre-start, start-up and shutdown procedures
- Relocating plant
- Preparing plant for screening operation
- Selecting and modifying the operating technique
- Conducting, controlling and monitoring operations
- Acting on or reporting monitoring systems and alarms
- Recognizing and responding to hazardous and emergency situations
- Completing work

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Resolve coordination requirements
- Carry out pre-start, start-up and shutdown procedures
- Relocate plant
- Prepare plant for screening operation
- Select and modifying the operating technique
- Conduct, controlling and monitoring operations
- Act on or reporting monitoring systems and alarms
- Recognize and responding to hazardous and emergency situations
- Complete work

Learning Instructions:

1 Read the specific objectives of this Learning Guide.
2 Follow the instructions described below.
3 Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding

them.

4 Accomplish the “Self-checks” which are placed following all information sheets.

5 Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet-1	Resolving coordination requirements

1.1 Mining plant coordination requirements screening

The most important factors determining whether surface mining can be done today are economic and technical, the price for the product, the cost of production, the quality and quantity of the deposit, the volume of overburden to be removed per ton of the deposit, and the feasibility of reclamation. The two primary types of coordination are internal coordination or establishing a relationship between all the employees, departments, etc. and external coordination or establishing a relationship between the employees and the outsiders. Coordination helps to bring together the human and material resources of the organization. It helps to make optimum utilization of resources. These mineral resources are used to achieve the objectives of the organization. Coordination also minimizes the wastage of mineral resources in the organization Coordination is the integration, unification, synchronization of the efforts of the departments to provide unity of action for pursuing common goalsTask dependencies drive the need to coordinate work activities. We describe a technique for using automatically generated archival data to compute coordination requirements, i.e., who must coordinate with whom to get the work done. Analysis of data from a large software development project revealed that coordination requirements were highly volatile, and frequently extended beyond team boundaries. Congruence between coordination requirements and coordination activities shortened development time.

The mining plant operator should:

- Notify the mining authority before starting operations at any mine and before discontinuing or abandoning any existing mining activity.

- Provide all the equipment, apparatus, facilities and finance to ensure, as far as reasonably practicable, good mining practice and an appropriate standard of occupational safety and health at the mine.
- Make sure everyone understands their safety and health responsibilities.
- Appoint, depending upon the number of mineworkers employed and the nature and extent of mining operations, one or more competent persons — supervisor to supervise and control the operations at the mine.
- Encourage the workforce to be actively involved in safety and health.

If there is a good management or coordination among mine plant operators and other mine workers:-

- It maximize the mine production,
- To save working hours.
- To share experience, skill ,knowledge
- It is easy to create a new technology
- To meet the required daily production safely, effectively

This instruction should include:

- Introduction to the working environment.
- Health and safety aspects of the task to be assigned.
- Hazard recognition and avoidance.
- Hazards relating to explosives.
- Ground control and working in areas of high walls.
- Hazards of machinery and equipment.
- Basic knowledge of first aid.

Screening operation safety rules**:-**

Follow directions and instructions

Use equipment correctly

Do not participate in 'horse play'

Know your emergency procedures and equipment

Stay alert

Aware mining rule and regulation

Understand your responsibilities

Conduct regular safety checks

Follow mine plant sign

Keep yourself fit and healthy

Look out for others

Treat all high risk environments with respect

Be familiar with the site and equipment

Wear personal protective equipment and clothing

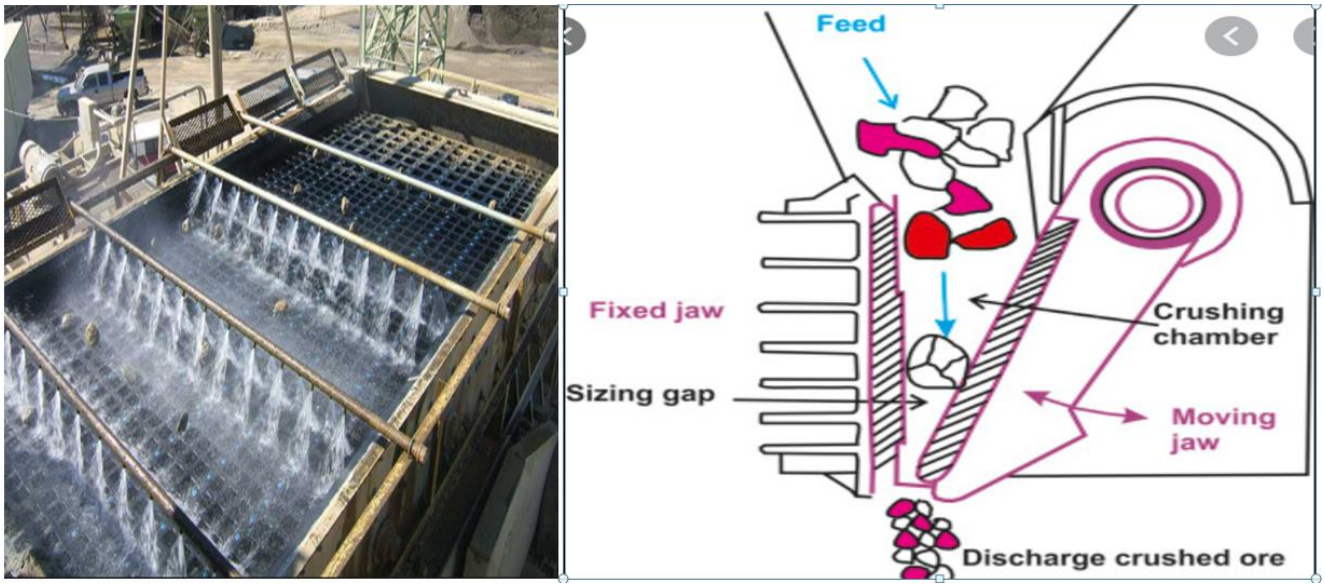


Fig 2: Mine plant operation

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements for coordination in mine operation? (3pts)
2. Mention the Screening operation safety rules:-.(3pts)
3. Define what does screening in mine plant operation means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	**Carrying out pre-start, start-up and shutdown procedures**

2.1 Mine Plant Setup:

A “Screen” can be simply defined as a machine with surfaces that are used to classify materials by size. For example — In a mining process, a screening plant is a type of machine used to extract ores from the ground using water and sedimentation processing. The importance of proper site preparation and proper stationing of the plant cannot be overemphasized. The mine site for stationing the plant should be flat, level, and well compacted. Crushing and screening plants may be operated for short periods of time from the wheelbase. However, from a maintenance standpoint it is advantageous on longer and more deliberate jobs not to operate the plant until it has been blocked and leveled with the tires clear of the ground. The plant should be leveled before initial operation and should be frequently checked while in operation. Leveling should be done on the frame for longitudinal leveling (Figure 6-10). Use a rigid, straight plank across the unit frame rails for transverse leveling. Check the leveling at several points throughout the unit. Inaccurate leveling may cause the drive belts and conveyor belts to run off, material to ravel to one side of screens

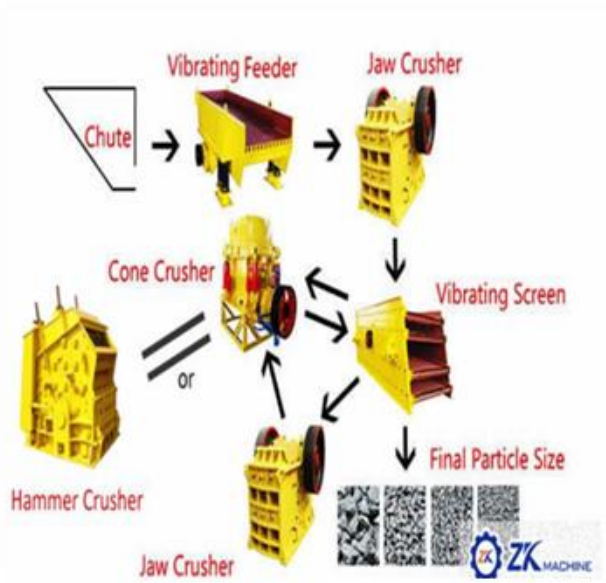


Fig 1: Mine plant operation

Plant Layout and Design:

Designers of new plants must be aware of ways of making a plant simple and economical to run; many plant modifications and additions can be justified by reductions in operating costs.

A well-designed plant layout balances the capital versus operating cost over mine life

Buildings: infrastructure and major equipment items represent the major cost elements of a crushing plant.

The designer must prepare a layout the suits the design criteria, flow sheet an

Selected equipment in the most economical possible configuration.

It's important to keep structural costs down, to design for ease of maintenance and operation, and to combine best practices with advances in fabrication and erection.

Input from an experienced mining plant structural engineer can be very helpful.

Crushing circuits and ancillaries have not changed a great deal over the years, so

Keep It Simple" is still the best way to design a plant.

Provisions must be made for the replacement of wear parts (e.g., install man-doors on head chutes with flood lighting inside the chute.) Faster part replacement means less downtime.

Layout tools can include cut-and-paste arrangements, 2D arrangements fitted

Onto site topography, or 3D CAD to superimpose the design on the selected site.

The choice of tool depends on whether the work is being done at the prefeasibility, feasibility or detailed engineering level, as well as on the accuracy required of any associated cost estimate.

The best designs are developed using basic approaches and tools: site visits,

Discussions with mine personnel, sketches, and cut and-paste layouts.

Different industries have different approaches to crushing plant design. The standard approach in the oil sands industry is to use Micro Station 3D CAD from the start; in some cases, the finalization of a system design (hopper, feeder, size crusher, and takeaway conveyor) has taken as much as two years, because of the uniqueness of the application. A similar design in the hard-rock mining industry takes from four to six months.

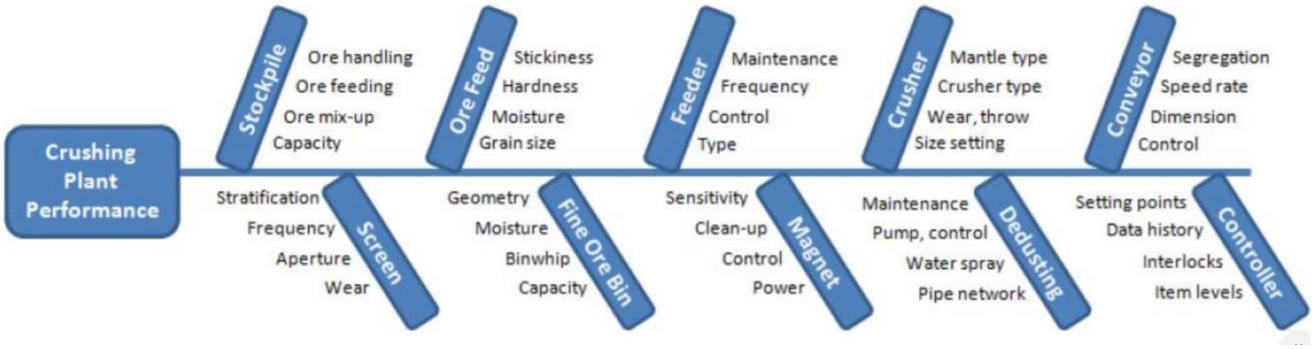
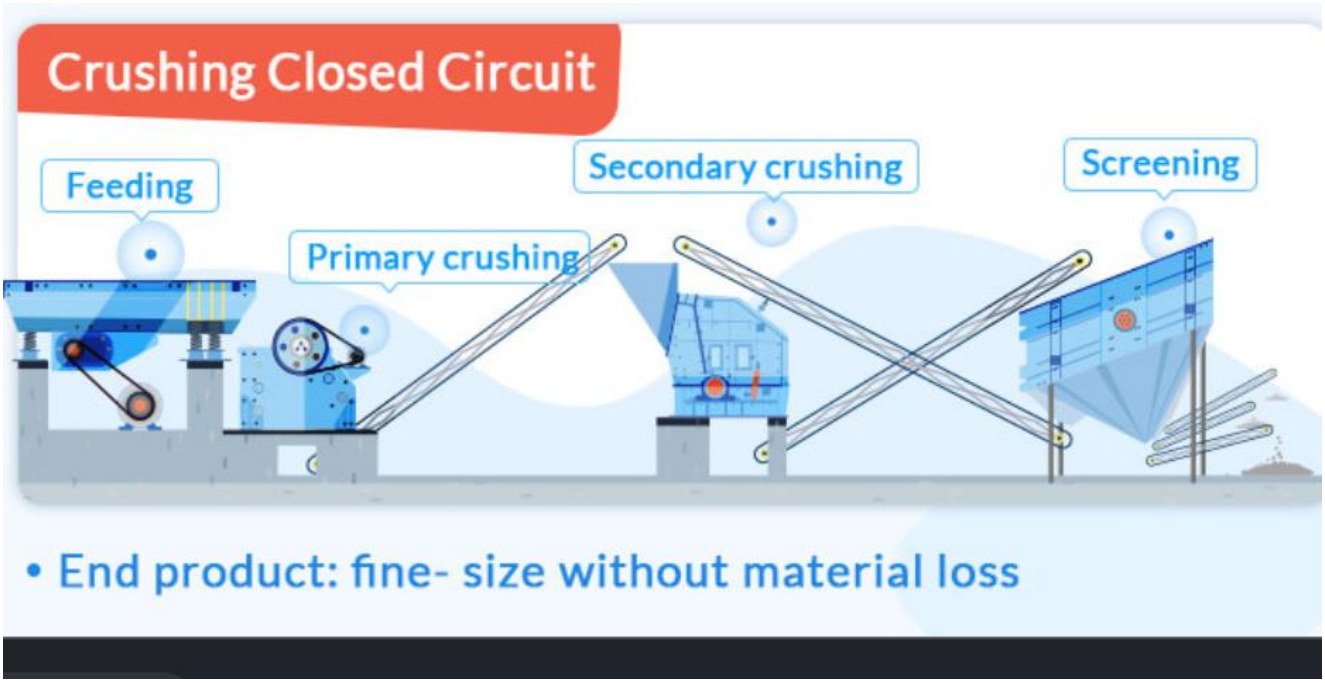
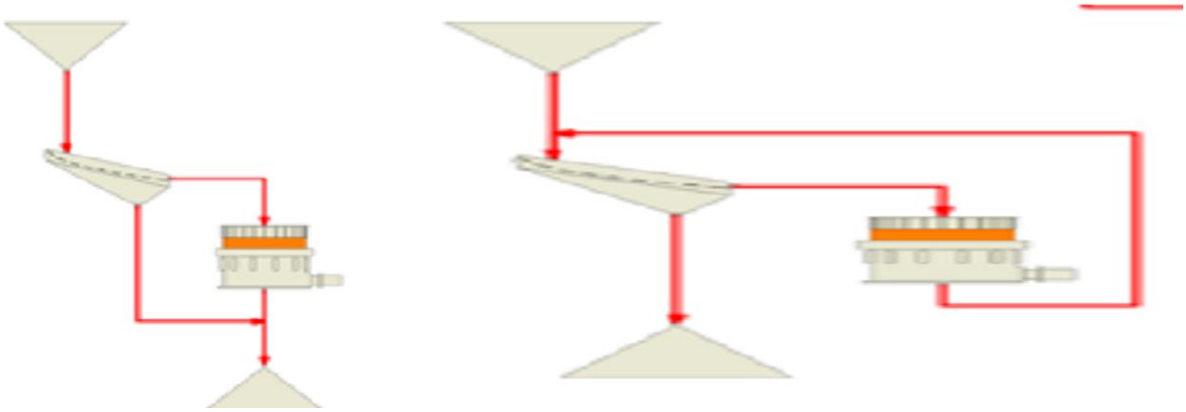


Fig 2: Cause-and-effect diagram showing factors that can influence plant performance

Crushing circuits – Open screening

Screening ahead of a crusher avoids packing
Less wear in the crusher
Higher total capacity
The screening Medias “controlling” the product in two dimensions. No “flaky shortcuts”.





a. Open **b. closed operation**

Crushing circuits – Closed screening

- ✓ The screens are lowering the capacity.
- ✓ Calibration of the product is improved.
- ✓ Better cubical shape.
- ✓ Higher reduction ratio.

Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the requirement for Mine Plant Setup ?(3pts)
2. Mention the characteristics of crushing circuit .(3pts)
3. Define what does stockpile mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Relocating plant

3.1 Mine plant operation:

Mine plant means any machinery, equipment, vehicle, tool, building, mill and plant, employees' housing or other Infrastructure whether movable or immovable. Surface mine plant operators control heavy-duty equipment such as excavators and dump trucks, often involving a high level of spatial awareness, to excavate, load and transport ore, raw mineral including sand, stone and clay and overburden at quarries and surface mines.



Fig 1 Mine plant equipment

3.2 Mine Plant Layout:

The most important goals when planning the layout of a crushing plant are that it meets production requirements, operates efficiently, and complies with all environmental regulations. Proper preparation and planning will ensure smooth plant operations. It is essential to take the time to properly plan out the setup and routing of the plant with the quarry/pit. Once the plant is in operation, there is rarely time to stop operations to reposition the equipment. In order to improve the process, both technical and economic factors must be taken into account. The optimization method utilizes both technical and economic calculations in order to find the most profitable solution. The aim of the optimization is to maximize the gross profit of the crushing plant (ie, income minus production cost).Crushing plant layouts can differ considerably from site to site. Plants are designed differently due to variations in the type of rock, the use of the products, the size of the quarry, plant history and many other factors. In order to optimize the plant it is necessary to have detailed information about the operating cost of each production unit.

3.3 Mine Plant Layout consideration:

- ✓ General site condition, which determines working environment for the machinery
- ✓ Formation of the deposit characteristics
- ✓ the type and ruggedness of the primary production equipment and the type of mining
- ✓ power availability
- ✓ site accessibility
- ✓ skilled labor availability

a. Feeding:

Feeders are necessary whenever it is desired to deliver a uniform stream of dry or moist ore, since such ore will not flow evenly from a storage reservoir of any kind through a gate, except when regulated by some type of mechanism. Feeding is essentially a conveying operation in which the distance travelled is short and in which close regulation of the rate of passage is required. Where succeeding operations are at the same rate, it is unnecessary to interpose feeders. Where, however, principal operations are interrupted by a storage step, it is necessary to provide a feeder. A typical feeder consists

of a small bin, which may be an integral part of a large bin, with a gate and a suitable conveyor. Feeders of many types have been designed, notably apron, belt, chain, roller, rotary, revolving disc, and vibrating feeders.

Fig 3: conveyor and screening plant

Conveyor Safety precautions:

The following safety precautions are generally applicable to conveyor systems:

1. Conveyors should only be used to handle material for which they were designed.
2. Belt capacity, and belt speed design ratings, should not be exceeded.
3. Only trained personnel should be allowed to operate conveyor systems. Operators should have complete knowledge of conveyor operation, electrical controls, safety devices, and warning devices, and the capacity and performance limitation of the conveyor system.
4. All personnel should know the location and operation of all emergency controls and safety devices. Areas near emergency controls and safety devices must be kept free of obstructions at all times.

5. All equipment must be inspected at the beginning of the shift, before the equipment is started. Guards, safety devices, and warning signs should be maintained in proper positions and in good working order. Only competent and properly trained and authorized

Persons should adjust and repair safety devices.

6. Another “walk-through” inspection should be made after the plant is started, in order to detect any problems with idlers, pulleys, shafts, bearings, drives, bolts, or belt splices. Listen for unusual sounds.

7. Poking at, or prodding, material on the belt, or any component of a moving belt, must be prohibited.

8. Contact with, or work on, a conveyor must occur only while the equipment is stopped, and the electrical control is properly locked out and tagged out.

9. People must not ride on, step on, or cross over a moving conveyor, except at designed cross-overs.

10. People should only walk, or climb, on conveyor structures by using the walkways, stairs, ladders, and cross-over’s that are provided.

11. Good housekeeping is a prerequisite for safe conditions. All areas around a conveyor, particularly those areas around drives, walkways, safety devices, and control stations, should be kept free of debris or any other obstacles. Any posted warning signs or instructions should be kept current.

12. Conveyors that are in an unsafe condition for operation, or that do not have all guards and safety devices in good condition, must not be used until all necessary repairs have been made.

13. All people should be barred, by appropriate means, from entering an area where falling material may present a hazard. Warning signs and barricades can be used.

14. First-class maintenance is a prerequisite for the safest conveyor operation. Maintenance, including lubrication, must be performed with the conveyor power locked-out and tagged. Special lubricating equipment, lube extensions, pipes, etc., can be installed so that lubrication of an operating conveyor can be done without any hazards.

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements to relocate mine plant?(3pts)
2. Mention Mine Plant Layout consideration.(3pts)
3. Define what conveyor belt means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Preparing plant for screening operation

4.1 Screens:

Screens are essential to the final aggregate product. The right screen selection will allow uninterrupted production of aggregate. Screens separate crushed rock into two or more particle size ranges. Screens are also used to remove oversized rock before they get into the secondary hopper and to separate out very small particles, also known as fines. Screens allow you to direct specific material to be given supplementary processing. Screening also allows you to select out material that does not need processing. Screening units are arranged from the larger holes on the top screen to smaller holes on the screens at the bottom. Each screen either passes the stone or scalps it off either to be reprocessed or to be stockpiled. The screen surfaces are vibrated to aid sorting. Crushed material is fed at one end and is separated into size ranges as it passes over the screening surface. Capacity and efficiency depend on how fast a screen can separate the material. The screen's performance can be aided by using the correct inclination, vibration speed, and direction of throw.

Fig 1: screening operation

4.1 General Procedure for plant screening

- Ore testing,
- Process definition,
- Production of basic flow sheet,
- Production of piping and instrument drawings,
- Production of general arrangement drawings and conceptual models,
- Equipment selection and specification
- Costing and preparation of definitive budget,
- Production of final flow sheet,
- Construction,
- Commissioning

Process design criteria:

- A statement of what the plant will be required to do and the framework in which it will have to accomplish it. It includes:
  - ✓ The capacity of the plant,
  - ✓ Material to be treated,
  - ✓ The sources of feed,
  - ✓ The product,

❶ Time schedule for the commissioning of the various stages,

➢ General information regarding the externally imposed parameters of the design.

➢ Normally prepared by the mining and financial consultants,

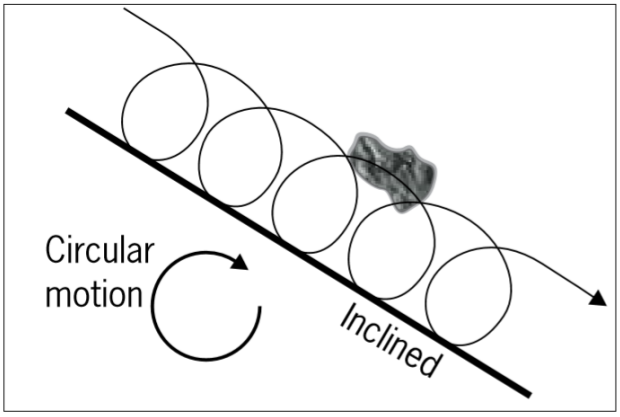
➢ Deals essentially with:

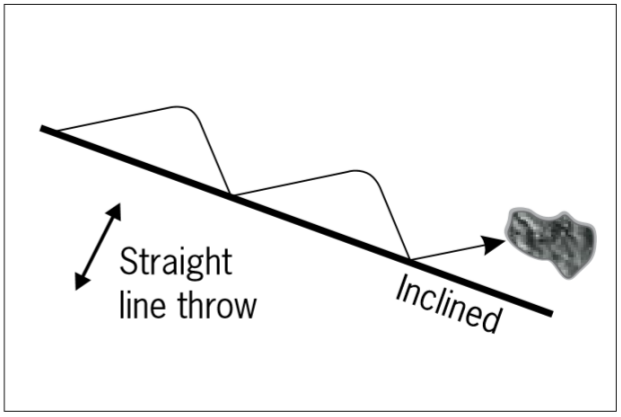
- What the plant is to achieve,
- Basic directive to the plant designer,
- Setting limits within which they should operate, And
- Targets they must attain.

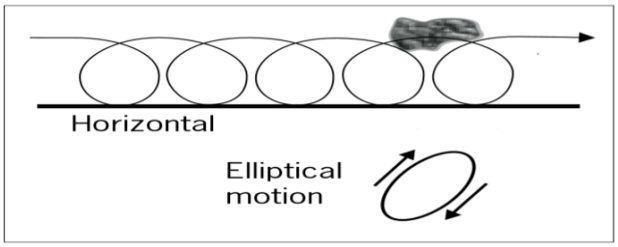
Screens:

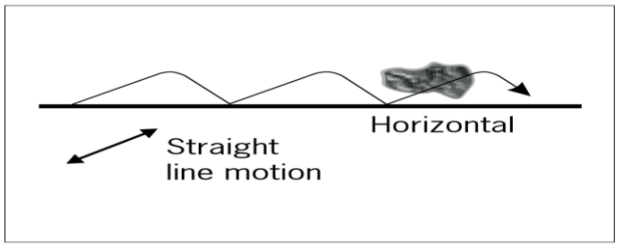
Performance of screens will fall back on three main parameters: Motion–Inclination–Screening media

Screen motions:



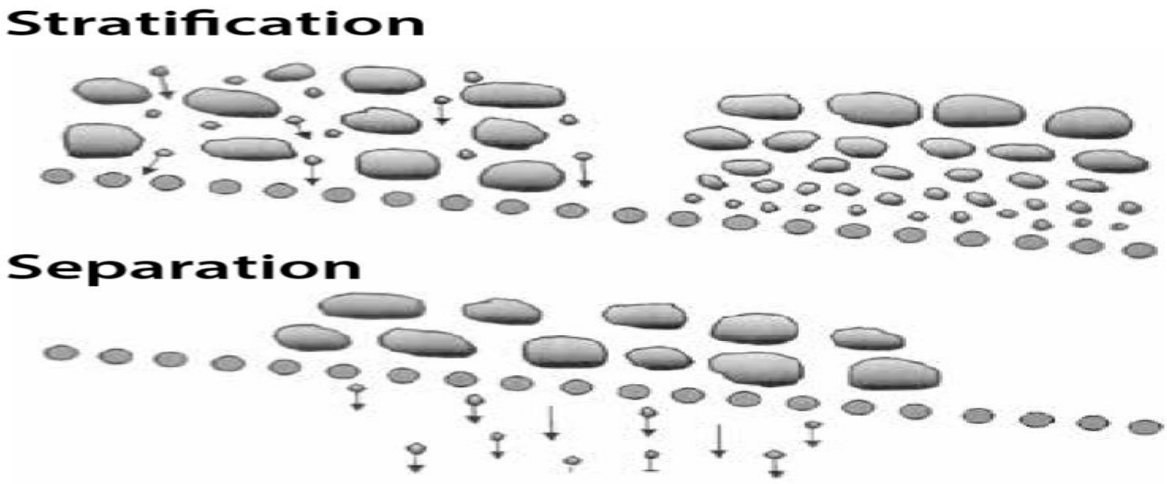






a. Screening by stratification

By building up a material bed on a screen deck the material will stratify when the motion of the screen will reduce the internal friction in the material. This means that the finer particles can pass between the larger ones giving a sharp separation



b. Screening by free fall

If we use the double inclination used for stratification (from 10-15 up to 20-30 degrees) we are in free fall, meaning that no particle layer can build up on the screen deck. The particles will now be sized directly via the screening media, giving a higher capacity, (or a more compact installation), but also less sharpness in separation. Optimal use when a large amount of fines shall be removed fast.

Importance of Good Plant Design and in Time Commissioning

- A good plant design can minimize capital expenditure and maximize on long term profits.
- A good plant design together with careful planning and execution of the startup can greatly contribute towards:
  - easing commissioning problems, and
  - Can ensure the plant brought into production in time.
  - To design capacity and efficiency, And Within budget.
  - Delays in commissioning can prove to become an extremely costly exercise in terms of profit loss due to loss of production

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the General Procedure for plant design?(3pts)
2. List down the Importance of Good Plant Design.(3pts)
3. Define what stratification means. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Selecting and modifying the operating technique

5.1 screening operation

Screening is a process of separating into groups of different products of various sizes. Each group consists of products of approximately same size. The mass which remains, on a screen is called the oversize of the screen and the material, which passes through the screen is, called the undersize. The screens in between the primary and the secondary crusher help in separating the oversize. The oversize goes to the secondary crusher while the undersize is discharged through a chute on to the same conveyor belt, which receives the discharge from the secondary crusher. This saves considerable power in the second crushing stage and also increases the capacity of the secondary crusher, as it eliminates possible choking of material in the crusher, particularly during wet weather or wet material.

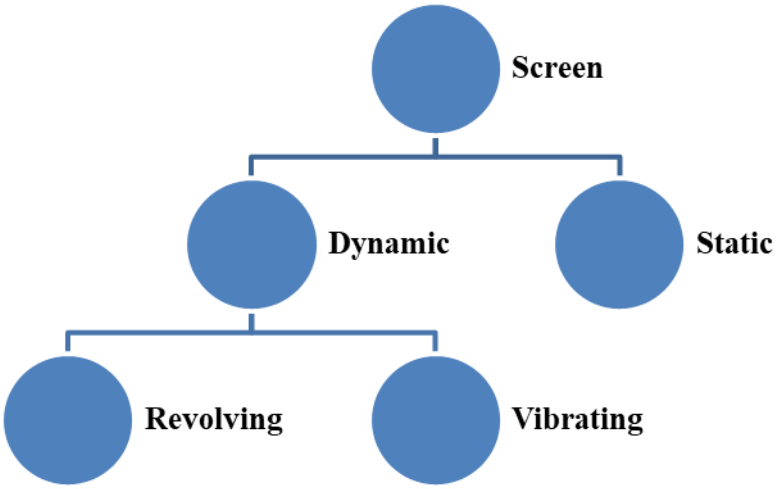
Fig 1: Sluice box with sieve

5.2 Screen Selection:

After the determination of material size has been made, you must select the proper screen. If the predetermined product size is less than one inch, the screen size should be one sixteenth larger; if the desired product size is between one and two inches, the screen should be one eighth larger; if the product size is between two and three inches, the screen should be a quarter inch larger; and for product size over three inches, the screen should be a half an inch larger. The number of screens to be selected is dependent upon the number of size ranges into which the material must be segregated and the type of equipment available for screening (Figure 6-5). Once the proper screen sizes have been determined, the product will be separated into the appropriate sizes and be passed to conveyor belts.

5.2.1Types of screens:

Most commonly, screens are used for size separations in conjunction with crushing operations. In the mineral industry, screens are rarely used for separations below 0.2 mm because they have inadequate capacity. However, sieve bends are used for separations as low as 50 μm since these devices give sharper separations than wet classifiers. Screens are classified as stationary and dynamic screens as shown below:

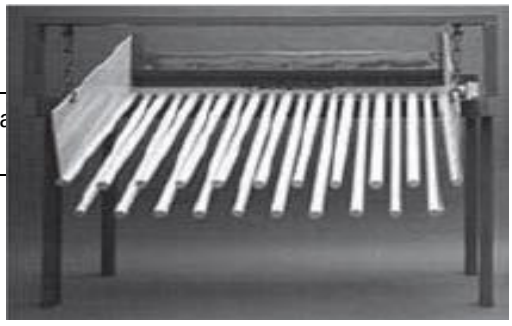


Principal types of Industrial Screens: Stationary Screens

1. **Grizzly**:
   - Equally spaced parallel rods or bars running in flow direction.
   - Sloped to allow gravity transport.
   - Lumpy or coarse separations.
   - Scalping before crushing.
   - Dry separation

2. **Divulgator**:

- Parallel rods running in flow direction.
- Fixed at one end.
- Gap increases from fixed to free end.

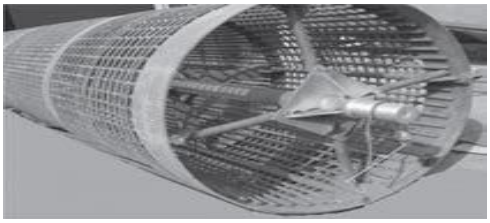


- Alternate rods diverge at 5º–6º.
- Applications: Separations in the range 400 to 25 mm size.
- Self-cleaning and blockage free.
- Dry separation.

3. Sieve Bend:

- Stationary curved screen with horizontal wedge bars at right angles to slurry flow.
- Feed slurry enters tangentially. Imparts centrifugal action.
- Separations in the range of 2 mm to 45 µm.
- Wet separation.

- **Revolving Type, Tromme**
- Rotating, punched or woven wire.
- Slightly inclined cylindrical shell.
- Applications Separations in the range of 10 to 60 mm.
- Dry if coarse, wet if fine.
- Also used for scrubbing lumpy or coarse.



4. Vibrating Type, Vibrating Grizzly:

- Similar to stationary grizzly.
- Mechanical or Electrical vibrations.
- Applications Coarse and Dry separations.
- Also used as feeders.

5. Vibrating Screen:

- High speed motion to lift particles.
- Mechanical or Electrical vibrations.
- Both horizontal and inclined types.
- Applications Separations from 200 mm to 250 μm.
- Dry if coarse, wet if fine.

Self-Check -5	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the difference between screen and conveyor ?(3pts)
2. Mention the Principal types of Industrial Screens.(3pts)
3. Define what Grizzly mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-6	Conducting, controlling and monitoring operations

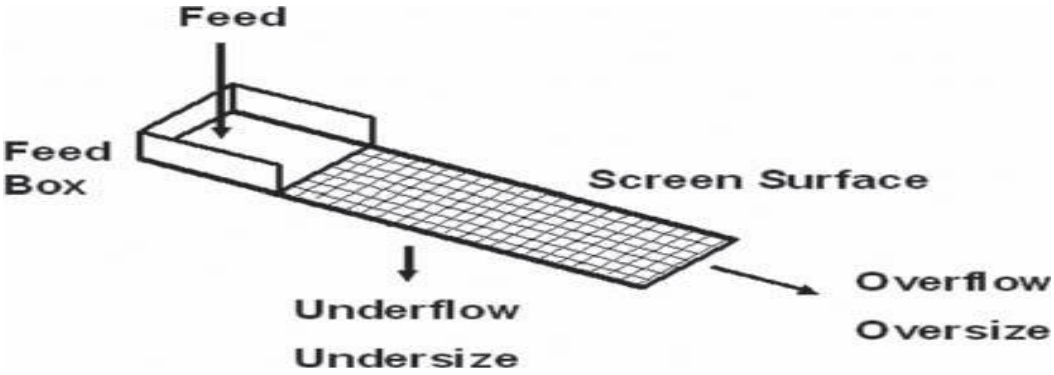
6.1 Introduction:

Screening is an operation used for the separation of particles according to their sizes. Sieving and screening are distinguished by the fact that sieving is a batch process used almost exclusively for test purposes, whereas screening is a continuous process and is used mainly on an industrial scale. Sieves are manufactured with definite dimensions and standard aperture sizes. Screens can be manufactured with any dimension and any aperture sizes as per the requirement. In industrial screening, the particles of various sizes are fed to the screen surface. The material passing through the screen aperture is called underflow (undersize or fines) while the material retained on the screen surface is called overflow (oversize or coarse).

Purpose of screening

Industrial screening is used:

- To remove oversize material before it is sent to the next unit operation as in closed circuit crushing operations.
- To grade materials into a specific series of sized (finished) products.
- To prepare a closely sized (the upper and lower size limits are very close to each other) feed to any other unit operation.



5.2 Monitoring Screening operations:

Screening is generally used for dry treatment of coarse material. Dry screening can be done down to 10 mesh with reasonable efficiency. Wet screening is usually applied to materials from 10 mesh down to 30 mesh (0.5 mm) but recent developments in the Sieve Bend Screen have made the wet screening.

possible at the 50 micron size. The material is fed at one end of the screen. Screening is effected by continuously presenting the material to be sized (the feed) to the screen surface which provides a relative motion with respect to the feed. The screen surface can be fixed or moveable. Agitation of the bed of material must be sufficient to expose all particles to the screen apertures several times during the travel of the material from feed end to the discharge end of the screen. At the same time the screen must act as a transporter for moving retained particles from the feed end to the discharge end. Particles of size more than the aperture size of the screen are retained and smaller particles are passed through the apertures. Both the oversize and undersize particles are collected as overflow and underflow separately.

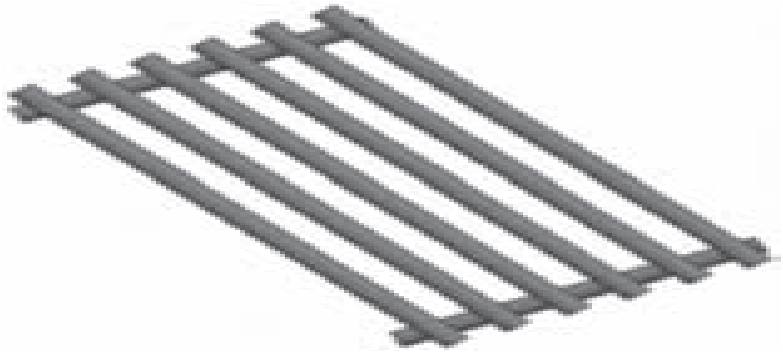
6.3 Screening surfaces:

A screen surface is the medium containing the apertures for the passage of the undersize material.

There are many types of screening surface available for industrial vibrating screens. The selection of screening surface for a particular duty will depend on the aperture required and the nature of the work. The selection of the size and shape of the apertures, the proportion of open area, the material proper- ties of the screening surface, and flexibility of the screen surface can be critical to the performance of a screening machine. Screening surfaces are usually manufactured from steel, rubber, or polyurethane, and can be classified according to how they are fixed to the screen. Bolt-in, tensioned, and modular fixing systems are used on industrial screens.

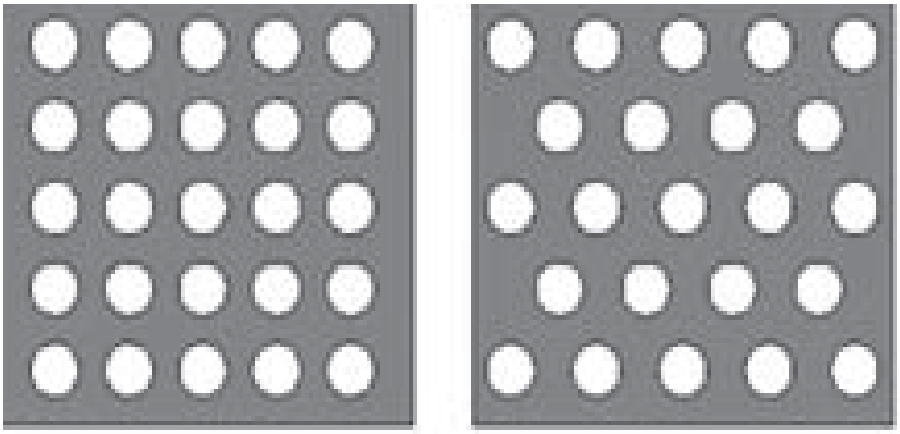
Types of screen surfaces:

1. Rod/bar Cross sections, Circular, Triangular, Wedge etc. and it is applicable for used for lumpy and coarser size particles.

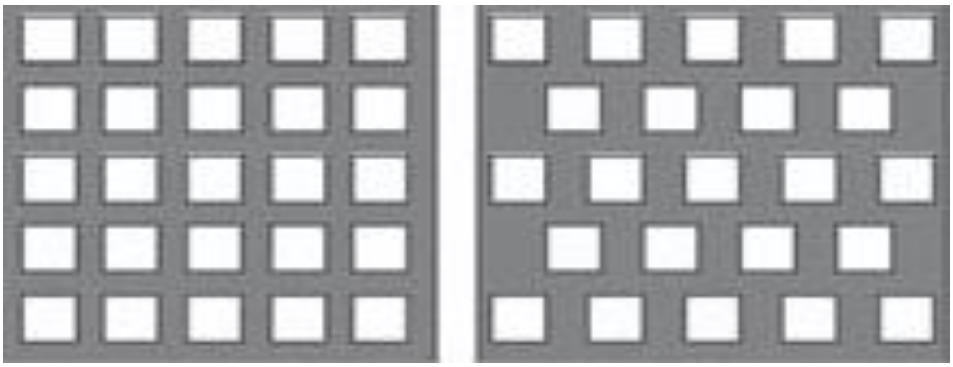


2 Circular, In-line and Staggered openings used for coarser and small sizes.

Name: **Punched or perforated plates**



3 Square In-line and Staggered openings used for coarser and small sizes



Punched or perforated plates

4. Slot-like, In-line and Staggered opening Small sizes slotted openings are sometimes Used for fine particles.

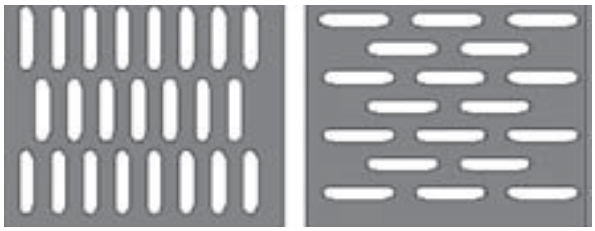


Fig Punched or perforated plates

Self-Check -6	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements for selection of Screening surfaces.(3pts)
2. Mention the Purpose of screening. (3pts)
3. List down the types of screening surfaces. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-7	**Acting on or reporting monitoring systems and alarms**

7.1 Introduction:-

Alarms used to alert vehicle drivers and workers on foot to dangerous situations must stand out from the normal working environment. The design of alarm thresholds is the top priority to reduce the number of false or missed alarms (alarms without the presence of abnormal situation or alarms, which do not appear in case of abnormality). In some cases alarm limits should change according to process operating mode, therefore mode based alarm system or dynamic alarm management might be needed. Other main contributors of high alarm numbers are the chattering alarms. any alarm occurring more than three times in a one-minute-period can be considered as a chattering alarm. In a more informal context, any alarm that appears with a disturbingly high frequency can be regarded as a chattering alarm. To avoid chattering dead bands, delay timers ,or filtering can be used.

7.2 Design Considerations for Alarm System:-

The worksite will use specific alarms for mining, plant or equipment. You must ensure that you are able to identify the alarms used on your mining site so that the appropriate response can be initiated. The sensing zone installed on the back of a haul truck. Alarms used to alert vehicle drivers and workers on foot to dangerous situations must stand out from the normal working environment. Ambient noise levels, lighting, and placement of alarm devices should be carefully considered. Creative alarming devices such as a tugging seat belt, vibrating steering wheels, and pager-type vibrating devices may be helpful. False (nuisance) alarms could cause workers to ignore the alarms over time. Maintenance and testing should be done regularly to ensure confidence in the safety system. It is applicable for explosive storage, office building, etc. Alarm signal transmit an display on the screen of the computer through alarm software. It is suitable for the miners on duty center. The alarm center monitors the state of the host and the zones through the internal network. It can also be applied to centralized management of chain super markets, franchise stores.

Design should consider:

Alarm types,

Nuisance alarms,

Environmental effects,

Safety assessments,

Fail-safe operation,

Electrical interference,

Operating range,

Sensor orientation,

Activation latencies,

Vehicles speeds,

Worker exposures,

Multiple device activation,

Explosives ignition hazards, and

Intrinsic safety issues.

Purpose of common Site and Workplace Alarms

To prevent or minimize physical and economic loss.

Used in workplaces to give an audible or visual warning about a problem or condition.

Reversing vehicle alarm is used to warn site users that a vehicle is reversing and the driver may have restricted vision.

Flashing or rotating light on an item of plant is used to warn site users that the plant is operating and the operator may be concentrating on the job in hand and may not be aware of persons in the vicinity

Smoke detector is used for the early detection of fire through identifying smoke in the area

Evacuation air horn alarm is a distinctive sound used to cut through ambient noise and warn site users to assemble at the evacuation point.

7.3 Recognize and Respond to Alarms:

Safety alarms are used in workplaces to give an audible or visual warning about a problem or condition. They can range from warning personnel/workers or visitors that a piece of plant or equipment is not functioning as it should, through to an emergency situation occurring. The main objective of alarms is to prevent or minimize physical and economic loss

- In the event of an emergency on a work site generally some form of visual or audible alarm will activate. The types of alarms may include:
- Alarm bell
- Electronic tone (warbling, whoop-whoop etc. often used for fire)
- Sirens
- Tones transmitted over site radio/communication systems
- Flashing lights

7.4 Alarm Response:

Your response to an alarm will depend on the type of alarm and the degree of concern that it demonstrates Often worksites will use digital or computer operated alarms. For this reason, it is important that you are familiar with the technology used, and are able to operate the systems. Major alarms on a worksite can tend to elicit a panic or "fight or flight" response from people. It is important that you remain calm, work participative with other personnel/workers and use your problem solving skills in order to work out what the alarm indicates, and how best to respond to it.

Self-Check -7	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the requirements of Monitoring systems and alarms in mine area?
2. Define what mean a Alarm.
3. What is the Purpose of common Site and Workplace Alarms?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-8	**Recognizing and responding to hazardous and emergency situations**

8.1 Emergency procedures:

An “emergency” means any situation arising from sudden and reasonably unforeseeable events beyond the control of the source, that require immediate corrective action to restore normal operation, and that causes the source to exceed a technology-based emission limitation under the permit, due to unavoidable increases in emissions attributable to the emergency. An emergency shall not include noncompliance to the extent caused by improperly designed equipment, lack of preventative maintenance, careless or improper operation, or operator error Site management will need to ensure that procedures for dealing with emergencies are in place. The most common emergencies that may occur on mining sites are fire and accidents. However, site management must plan for all possible emergencies (the type of emergency that may occur will depend on the type of work being carried out and the site’s location). These matters should be addressed before any site work commences.

Emergency Situations:-

Emergency situations encountered in a workplace may include:

- Fire
- Emergency evacuation
- Incident or injury
- Electrical shock
- Falls

Cyclones and other extreme weather

- Entrapment
- Inrush
- Fumes
- Explosions Emergencies resulting from working in remote locations

Figure 1: Emergency situations

Common mine working activities and hazards:

1. Work at height:

Working at height means working at a level where a worker may fall a distance likely to cause personal injury. Examples of this include: working on a roof, working on the floors of a building under construction, working at ground level where the worker may fall into an excavated area, and working on ladders. All workers and supervisors must therefore receive information and training on the perception of the risk and on safe working practices with regard to work at height.

2. **Working with vehicles:**

Moving vehicles often cause injuries to workers on mining sites. The vehicle movements consist, inter alia, of goods vehicles involved in deliveries, dumper trucks transporting spoil, excavators used in ground works, and vehicles transporting workers. The injuries are sustained as a result of workers being struck by a vehicle (particularly during reversing operations), workers fall off the vehicle or being struck by loads falling off the

vehicle, or by the vehicle overturning. The planning of work activities will affect the numbers of vehicles that are needed on site..

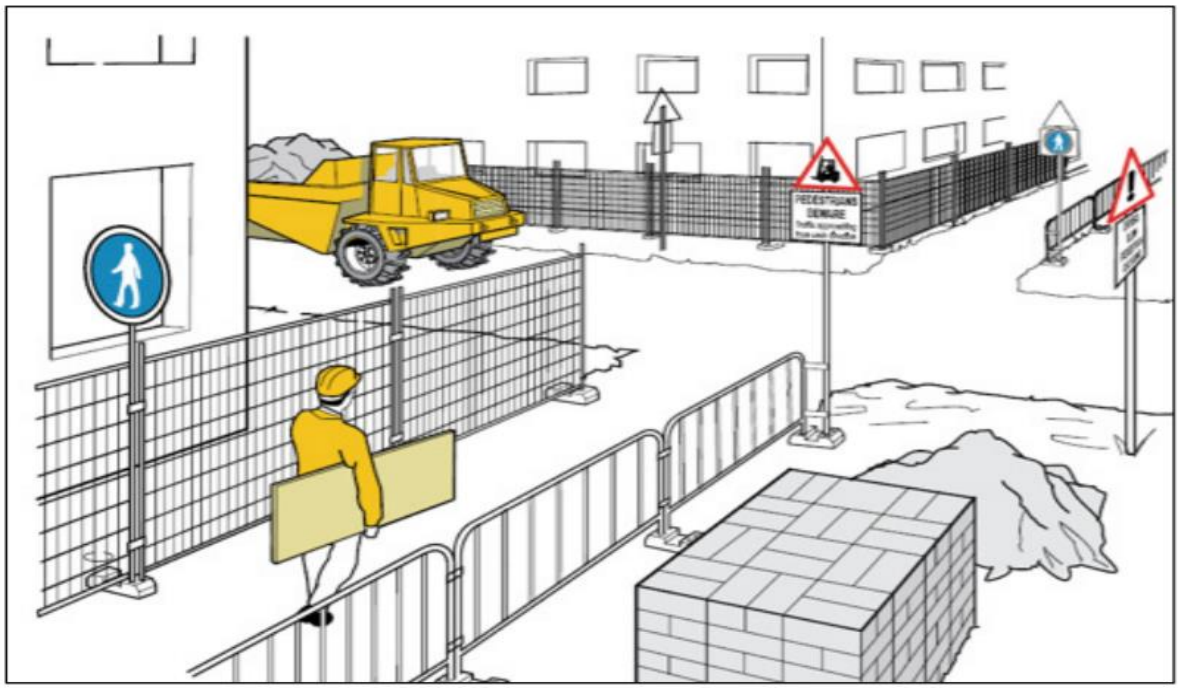


Figure 2: A well designed pedestrian and vehicle crossing point

8.2 Identify your Responsibility in Emergency Situations:

Every worksite will have specific procedures to be followed in response to emergency situations. These procedures will differ based on:

- The type of emergency,
- Its severity and
- The impact it will have on personnel/workers.

If you are unsure of your responsibility on your worksite, seek clarification from supervisor or other Work Health & Safety (WHS) personnel/workers.

a. **Emergency Planning:**

Emergency preparedness planning for major hazards is significant and is now a part of planning process. Although all process and operating parameters are integrated to safety, it is important to plan for emergency handling so as to face it in case it strikes. Emergency planning exercises for on-site and off-site scenarios required for preparing a

Disaster Management Plan (DMP) are different; however, they should complement each other. This study has focused on the possible hazards confined within the Premises and the corresponding action plan (On-site plan). The responsibilities and actions expected from the Government Departments during an emergency will be sought for off-site plans.

b. **Communication System**:

Different types of alarms to differentiate types of emergencies will be provided. Willkie talkie using predetermined codes of communication, are very useful during emergency. Cell phone can also be an effective communication arrangement.

c. **Emergency Services:**

This includes the fire-fighting system, first aid center, dispensary etc. Alternate sources of power supply for operating fire pumps, communication with local bodies, fire brigade etc. will also be clearly identified. Adequate number of external and internal telephone connections shall be installed.

8.3 Respond to and Report Emergency Situations

It is essential to have adequate emergency response procedures in place in the event of an emergency. Your response to an emergency will depend upon your role and responsibility within the workplace. The alarm should be raised at once if there is an emergency, and supervisors or other personnel/workers must be informed. If all procedures, equipment and personnel/workers are prepared, an emergency response can be conducted without delay. It is important that all workers stay calm and focused in a crisis. The quicker and more effectively all personnel/workers can react in an emergency the better the outcome.

Figure 3: Responding to Ambulance

Principal hazard management plans:

Principal hazard any hazard arising at any mining operation that could create a risk of multiple fatalities in a single accident or a series of recurring accidents at the mining operation in relation to any of the following:

- ✓ ground or strata instability:
- ✓ inundation and inrush of any substance:
- ✓ mine shafts and winding systems:
- ✓ other vehicle operating areas:
- ✓ tips, ponds, and voids:
- ✓ air quality:
- ✓ fire or explosion:
- ✓ explosives:
- ✓ gas outbursts:
- ✓ spontaneous combustion in coal mining operations; and

any other hazard at the mining operation that has been identified by the site senior executive.

Self-Check -8	Written Test

Directions: Say **TRUE** or **FALSE** for the following questions Use the Answer sheet provided in the next page:

1 Explosion is not one of emergency situations encountered in a worksite.

1 Every worksite will have specific procedures to be followed in response to emergency situations.

2 Depending on your role in the worksite, your responsibility in regard to emergency procedures will vary.

3 It is necessary for a trained person to apply first aid in emergency situations.

4 All important information such as the nature of the emergency, contact details, location and actions should be reported on time.

5 Principal hazard any hazard arising at any mining operation that could create a risk of multiple fatalities in a single accident or a series of recurring accidents at the mining operation

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

LG #39	**LO #4** Carry out post-operational procedures

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Inspecting fault-find and report faults
- Operational maintenance**,** servicing and housekeeping
- Passing records and reports

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Inspect fault-find and report faults
- Operational maintenance**,** servicing and housekeeping
- Pass records and reports

Learning Instructions:

1 Read the specific objectives of this Learning Guide.
2 Follow the instructions described below.
3 Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4 Accomplish the “Self-checks” which are placed following all information sheets.
5 Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet-1	Inspecting fault-find and report faults

1.1 Conveyor accidents and damage prevention:

Conveyor accidents that cause personal injuries do not normally occur because of faulty equipment design or component failure. These accidents are usually caused by human error, inadequate training, or lack of hazard awareness. Employees should receive safety training, after the conveyor is designed and the system is installed by qualified personnel. Supervisory, operating, and maintenance personnel should be instructed in safe operating procedures, hazard recognition, and housekeeping skills. Periodic refresher training should be given in these subjects. Unauthorized employees should not be permitted to enter hazardous areas. All workers - especially maintenance personnel - should be provided with proper tools and equipment to operate, and maintain, the conveyor in a safe condition.

1.2 Common accidents:

One common type of accident involving conveyors occurs when an employee stops a conveyor to perform work on it, but does not properly lockout and tag the electrical controls. Another employee, noticing that the belt is stopped, restarts it - injuring the employee that is performing the work. Another common accident involving conveyors occurs when an employee becomes caught in unguarded, or inadequately guarded, moving equipment. The guards may not have been installed, or, more commonly, the guards may have been removed to perform work. Also, the guards may have been previously removed and not replaced. Employees should be sure that equipment guards are properly installed and maintained.

1.3 Damage prevention:

The belt is the most expensive item in a conveyor system. Therefore, proper belt operations, and belt maintenance, are particularly important in order to minimize repair and replacement costs. Weather can affect belt operation. In sub-zero temperatures,

special lubricants are sometimes necessary in order to avoid overloading the drive motor. The belt may sometimes be covered with moisture, frost, or frozen material. A belt scraper, installed just ahead of the point where the belt goes onto the drive pulley, may be useful for removing frost, or frozen material, that is stuck to the belt. Operating the belt for a brief period, at start-up, before loading it, may be advisable, in order to remove frost or frozen material. Sticky or frozen material on pulleys or idlers can cause belt misalignment, or other damage. Pulley scrapers, and/or soft rubber pulley lagging, may help to correct this condition. No one should be allowed to remove stuck material from the belt, unless the belt is stopped and the master electrical control is locked out and tagged. Belts can be damaged, or prematurely worn, if loaded with improper sizes or volumes of material. Foreign objects, such as tramp iron, spikes, or timbers, in the material flow can jam the belt, causing expensive shut-downs and repairs.

Stuck idlers, under a high speed belt, can wear through to a knife edge that can severely damage a belt. Plant operators should be alert for impending idler failures, and correct malfunctions before the belt is damaged.

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements for prevention of accident?(3pts)
2. Mention the Common accidents in mine plant.(3pts)
3. Define what does Conveyor accidents mean. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	**Operational maintenance, servicing and housekeeping**

2.1 Maintenance systems:

For the job of conveyor operation and maintenance, the basic job steps, potential accidents and hazards, and recommended safe job procedures. This job is usually done by the plant operator and maintenance personnel, but it may be done by other occupations, such as utility worker, laborer, etc. The plant operator and maintenance personnel must make sure that employees, and others, are protected from accidents and injuries resulting from conveyor maintenance. Each conveyor system has its own performance requirements, design features, and operating environment. Frequently used repair parts should be stocked at the plant site, in order to maximize plant dependability and productivity and minimize maintenance costs and downtime.

2.1.1 Maintenance Requirements:

Properly maintaining the belts is one of many vital operating practices necessary to keep respirable dust levels low along the belt entry. Missing rollers, belt slippage, and worn belts can cause belt misalignment and create spillage. Given the increases in the quantity of ore being transported out by the face, operators must be diligent in their efforts to properly maintain the existing belt entry dust suppression controls to keep fugitive dust from being entrained and carried by the ventilation airstream to the face area. Plants must be designed for ease of access and maintainability if they are to meet their production goals. Keeping maintenance requirements to a minimum help achieve higher overall operating availability. Scheduled preventive maintenance at crushing plants involves a number of elements, including:

- Crusher wear parts
- Screen decks
- Feeder wear parts
- Conveyor skirting and adjustment

- Oil and lubrication
- Conveyor belt repair
- Visual inspections
- Electrical and instrumentation adjustments

Fig: Maintaining conveyor systems

Maintenance considerations include:

➔ where servicing is needed

➔ how much servicing is needed

➔ what kind of servicing is needed

➔ How often servicing needs to be done.

2.2 Servicing operation:

The following documented safe work procedures, including manufacturers' instructions

- proximity to hot or sharp parts
- cool-down or warm-up periods
- run down periods
- lock-out provisions or permission for guard removal
- enough room to do tasks without risk of injury or strain
- stored energy in the machine or materials being processed
- any additional hazards from maintenance procedures – such as testing while the machine is unguarded (a 'dry run' or 'trial run'), working at heights, use of solvents
- Maintaining or updating service records.

2.3 Housekeeping:

Maintain good housekeeping practices, store sampling supplies, coolers, tools, and equipment orderly and out of the main traffic area to avoid unnecessary slip, trip, and fall hazards Good housekeeping is a proactive approach to keeping the job-site clean which in-turn reduces accidents and injuries. A clean work environment adds to mine speed and efficiency Housekeeping means cleaning-up, which is an ongoing part of crushing, rather than an occasional activity. **T**hose in control of the site must plan how it will be kept tidy.

Follow these suggestions to make your housekeeping efforts more efficient:

Place fire extinguishers and first aid kits in easily accessible locations.

Decide on a location for trash collection: All trash should be placed in bags and stored in areas outside of the immediate work area.

Good housekeeping can eliminate most trip hazards,

Keep all controls, control linkages, warning and operation lights, and lenses free of oil, grease, and ice.

Do not store gasoline in any portable container other than a self-closing, non-sparking, red container with flame arrester in the fill spout and having the word gasoline clearly visible. The container must also comply with all other hazard communication requirements.

Never use compressed air for cleaning clothes.

Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements to Maintain good housekeeping practices?(3pts)
2. Mention some of the considerations Servicing matters.(3pts)
3. List down at least five Maintenance Requirements. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Passing records and reports

3.1 Records & reports

The first requirement for safe field operation is that everyone understands and fulfills the responsibility for **recording and reporting** on and around the mine site.

Standardized work practice is a tool for maintaining productivity, quality, and safety, at high levels.

Standardized work practice is defined as work in which the sequence of job elements has been efficiently organized, and is repeatedly followed by workers.

3.2 Maintain and process records and reports in mine work site:-

- Provides a basis for employee training
- Establishes process stability
- Reveals clear stop and start points for each process
- Assists audit and problem solving
- Creates baseline for kaizen
- Enables effective employee involvement
- Maintains organizational knowledge

A dust collector includes a dust container; a centrifugal separator installed inside the dust container to separate dust from air; a filter unit installed at a discharge hole of the centrifugal separator and provided with a filter member; and a dust-removing device for dislodging dust from the filter unit. The dust-removing device includes a dust removal unit including a dust-removing member having dust-removing projections formed on an undersurface thereof, wherein the dust-removing projections move back and forth while contacting the filter unit to dislodge dust from the filter unit; and a drive unit for providing driving power to the dust removal unit.

Designers must design machinery and plant that is safe to use. Some examples of designing machinery for safe operation:

Consider the type of seating an operator may use and the ease of using the controls from the seat.

If an operator needs to move around a large machine, provide a portable emergency stop button.

Give easy and safe access to areas that need regular maintenance. Access will be needed for cleaning, lubrication and adjustment. Maintenance considerations include:

routine adjustments – people should be able to do these with the machine stopped but without needing to remove safeguards or take apart any of the machine

- when frequent access is needed – use interlocked guards
- when access is difficult – consider self- lubrication or central lubrication for parts
- Positive lock-off devices to stop the machine restarting accidentally, particularly if a machine was shut down in error.

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements of Mine plant operation?(3pts)
2. Mention the stages of life of mine .(3pts)
3. Define what mean a waste dump. (4pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

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