Fruit and vegetable processing II

Based on *October, 2019*, Version 2 Occupational standards (OS)

Module: - Operating an Evaporation Process

LG Code: IND FVP2 M15 LO (1-3) LG (55-57)

TTLM Code: IND FVP2 TTLM 1020V1

October 2020

Bishofitu, Ethiopia

United Nations
Educational, Scientific and
Cultural Organization

Project Financed by the UNESCO

Contents

LG #55	LO #1- Prepare the evaporation process for operation

Instruction sheet

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

- Confirming available materials
- Identifying and confirming cleaning and maintenance requirements
- Entering processing/operating parameters
- Checking and adjusting equipment performance
- Carrying out pre-start checks

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Materials are confirmed and available to meet operating requirements
- Cleaning and maintenance requirements and status are identified and confirmed
- Processing/operating parameters are entered as required to meet safety and production requirements
- Equipment performance is checked and adjusted as required
- Pre-start checks are carried out as required by workplace 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).
6) If you earned a satisfactory evaluation proceed to “Operation sheets
7) Perform “the Learning activity performance test” which is placed following
8) If your performance is satisfactory proceed to the next learning guide,
9) If your performance is unsatisfactory, see your trainer for further instructions or go to operation sheet.

Information Sheet 1- Confirming available materials

1.1 Introduction

Evaporation is commonly used to remove water from dilute liquid foods to obtain a product with a desired solid concentration.

Evaporation and dehydration are the two common methods used in food processing industries to remove water from a food product.

Evaporation differs from dehydration in the fact that the final product in evaporation process is concentrated liquid whereas the final product in dehydration process is solid. Dehydration process removes moisture from the food products to achieve a dried solid Product with desired moisture content.

Another water removing process in food industry is distillation. Distillation differs from evaporation in the sense that it is used as a purification method for liquid solutions. In distillation process, the undesired liquid fraction is removed from a liquid product by heating the product.

Although the level of a lake, pool, or glass of water will decrease due to evaporation, the escaped water molecules don't disappear. They stay in the atmosphere,
affecting humidity, or the amount of moisture in the air. Areas with high temperatures and large bodies of water, such as tropical islands and swamps, are usually very humid for this reason. Water is evaporating, but staying in the air as a vapor.

Once water evaporates, it also helps form clouds. The clouds then release the moisture as rain or snow. The liquid water falls to Earth, waiting to be evaporated. The cycle starts all over again.

Many factors affect how evaporation happens. If the air is already clogged, or saturated, with other substances, there won't be enough room in the air for liquid to evaporate quickly. When the humidity is 100 percent, the air is saturated with water. No more water can evaporate.

Air pressure also affects evaporation. If air pressure is high on the surface of a body of

water, then the water will not evaporate easily. The pressure pushing down on the water makes it difficult for water to escape into the atmosphere as vapor. Storms are often high-pressure systems that prevent evaporation.

Temperature, of course, affects how quickly evaporation happens. Boiling-hot water will evaporate quickly as steam.

Evaporation is the opposite of condensation, the process of water vapor turning into liquid water.

1.2 Confirming Materials

Materials in the process of evaporation may sometimes be subject to chemical reactions at particular temperatures or concentrations. If these reactions are undesirable, it's important to avoid the process conditions that will lead to those specific circumstances. There are two major factors to consider in the material selection process for an evaporation system: corrosion and cleaning.

Evaporators usually operate under harsh environmental conditions. They may process corrosive fluids that may contain chlorides, acidic agents, or caustic chemicals. For that reason, it is imperative that evaporators are constructed from durable and resilient materials.

The following examples demonstrate the importance of material choice:

- **Stainless Steel**

some applications demand high levels of hygiene, so they must bear frequent cleanings and exposure to caustic or acidic cleaning chemicals. Many manufacturers use 304 and 316 stainless steel for hygienic evaporators. They polish surfaces with which the product will come into contact, ground welds for optimal smoothness, and construct piping and other pieces of equipment according to specific codes.

- **Other Metal Alloy**

Thermal Kinetics employs a number of specialty metals depending on the application. Some examples include:

  - Titanium: Calcium chloride and other halogen salt solutions
  - Duplex stainless steel: Lower concentration neutral salt solutions
  - Nickel: Caustic soda and caustic potash
  - Hostelry: Phosphoric acid evaporators

- **Graphite**

Graphite features a high level of corrosion resistance against common acids and solvents, including sulfuric acid. Thus, it is an excellent choice as a source material for the construction of a sulfuric acid evaporator, since it can prevent heat exchanger corrosion and also provide an adequate level of heat transfer. Consult with Thermal Kinetics for other services. In many cases there are industry proven selections. In other cases corrosion testing is required to find the best choice.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test II: Short Answer Questions (10%)

1. What is Evaporation _____ (5 point)
2. Write down the importance of material choice?_____(5 point)

You can ask you teacher for the copy of the correct answers.

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

Information Sheet 2:- Identifying and confirming cleaning and maintenance requirements

2.1 Cleaning

Cleaning is the complete removal of dirt particles from the surface of machines, tools and equipments using appropriate detergent chemicals under recommended conditions. It is important that personnel involved have a working understanding of the nature of the different types of food soil and the chemistry of its removal in order to maximize product quality and health promotion.

2.1.1 Cleaning Methods

There are various methods which can be used to apply detergents and disinfectants for cleaning and sanitizing machines and equipments activity.

a. Manual cleaning

Manual cleaning is practiced using cloths, mops, brushes, pads, etc. It is normally used in small areas, equipment that is non-water proof or requires dismantling or areas which are difficult to clean by other methods. It is a labor intensive method and may limit the use of certain chemicals for safety reasons. There should be

b. Spray cleaning

Spray cleaning uses a lance on a pressure washer with chemical induction by venture. This method can be wasteful of chemical and can be slow to produce foam. It should be used where foaming properties are not essential for the cleaning action.

c. Foam cleaning

This is the common method for cleaning most food operations. A foam blanket, created using a wide range of available equipment is projected from a nozzle and allowed time to act on the dirt particle.

.It is then rinsed off with the released deposits. Large areas such as floors, walls, conveyors, tables and well-designed production equipment are ideal for foam cleaning. Foam is a carrier for the detergent. The foam should be applied in an even layer. Coverage rates are quick and chemical usage is economical.

Fig 2.1 Foam cleaning

d. Machine washing

This is normally an automatic or semi-automatic washing process conducted within a purpose built machine. There are many machine designs depending on the application. But failure to maintain them correctly can lead to a contamination risk to the product. Chemicals used in these machines should be low foaming. An effective system for controlling the dose of chemical should be employed and temperature control systems should be used where critical.

2.1.2 Cleaning procedure

Cleaning is a complex process. To ensure it is conducted correctly a defined and systematic approach is required that takes into account a number of factors previously covered. This approach takes the form of a Procedure and this is usually a legal requirement in addition to a fundamental requirement of global food standards.

The correct sequence of a general cleaning procedure during evaporation process:

- Gross Clean/Preparation
- Pre-rinse
- Detergent application
- Post-rinsing
- Disinfection

2.2 Identification of Maintenance requirements

Maintenance is a general upkeep and repair of equipment, buildings and grounds, heating and air-conditioning; removing toxic wastes; parking; and perhaps security.

The objective of plant maintenance is to achieve minimum breakdown and to keep The Plant in good working condition at the lowest possible cost.

Proper maintenance is critical to personnel safety, smooth equipment operation and lasting performance. A production system or individual piece of equipment requires regular maintenance to help promote equipment safety, provide an optimum end product and to prevent costly down time. Failure to practice proper maintenance procedures as noted in the equipment manual can lead to unsafe conditions and shorten the life of the equipment operation tools, parts, materials and procedures

Just before going to run out maintenance activity, a technician makes sure:-

Food premises and equipment that are not kept in good repair and condition are a potential source of microbiological and physical contamination of food. Poor maintenance may allow the entry of other sources of physical, microbiological and chemical contaminants such as water, pests and dust. Poor maintenance can have health and safety implications for workers. Maintenance may include:

- Hand sharpening
- Cleaning
- Lubricating
- Simple tool repairs and adjustments.

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Instruction: Short Answer Questions (20 points)

1. Define cleaning? (5 points)
2. Write cleaning methods? (5 points)
3. Write the correct sequence of general cleaning procedures? (5 points)
4. Mention and discuss types of maintenance? (5 points)

.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3;- Entering processing/operating parameters

3.1 Introduction

Evaporation is a unit operation that separates a liquid from solids by means of heat transfer via vaporization or boiling. The purpose of evaporation is to concentrate a solution of a nonvolatile solute (i.e., solids) and a solvent (i.e., liquid), which is typically water. Evaporating a portion of the solvent concentrates the solute into a more-viscous liquid product. Evaporation is regularly used in the food processing, chemical, Kraft paper, and pharmaceutical industries to produce liquid concentrates.

3.2 Operation procedure during evaporation process for operation

Operating procedures are followed to start and operate equipment to achieve required outcome. Provision of clear, concise and accurate operating procedures is the most effective measure to prevent, control and mitigate accidents.

This procedure aims to:

- Increase employee awareness on the safe use of equipment used in the workplace;
- Ensure that work equipment is suitable for the purpose for which it is to be used or has been provided;
- Ensure that work equipment is inspected at regular intervals;
- Ensure that work equipment is maintained in good working order and kept in a good state repair;
- Ensure employees receive relevant information, instruction and training (where this is required and/or appropriate) in relation to using work equipment.

Comprehensive written operating procedures should be generated where applicable that address:

- Standard operating procedures and operating philosophy;

- Abnormal operating procedures;
- Temporary operating procedures;
- Plant trials;
- Emergency operating procedures;
- Plant Start-up;
- Plant Shut-down;
- Bulk loading and unloading;

These procedures should cover the following;

- Material safety data control of substances hazardous to health (COSHH) states that general requirements on employers to protect employees and other persons from the hazards of substances used at work.);
- Plant operatives should have an awareness and understanding of material safety data for raw materials, intermediates, products and effluent / waste;

N.B: material safety data sheet (MSDS) is the document that list information relating to OHS for the use of various substances and products. These include:

- Control measures and personal protective equipment;
- Location of plant where process to be undertaken;
- Roles and responsibilities of individuals involved in plant operations;
- Plant fit for purpose;
- The condition of main process plant and equipment (clean, empty etc. as appropriate) should be established as being fit for purpose;
- Plant correctly set-up for processing;
- Process monitoring and recording;
- Monitoring and recording of key process parameters (temperature, pressure etc.);
- Quality;
- Sampling of raw materials, intermediates, products and effluent/waste;

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Instruction: Short Answer Questions (15 points)

1. Write down aims of operating parameters/procedures? (5 points)
2. What is material safety data sheet (MSDS)? (5 points)
3. Write down point's safety data sheet include? (5 points)

.

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Information Sheet 4:- Checking and adjusting equipment performance

4.1 Evaporation Equipment

Evaporation technology is used in any process that requires concentration of a stream by removal of water or other solvent. The process of evaporation is energy- intensive; any evaporator system design approach needs to take great consideration into the heat recovery philosophy and overall utility usage of the final system design.

Product characteristics also need to be considered in the system design; many product characteristics can be altered in an evaporation process,

4.1.1 Evaporators are used across an array of industries, such as

- Chemical Production
- Food and Beverage
- Pharmaceutical Production
- Agricultural Chemical Production
- Pulp and Paper
- Oil and Gas
- Fuel Ethanol

Some of the specific applications within these industries that use Evaporation systems include.

- Chemical Plant Waste Systems
- Removal Of Solvents From Oils
- Cannabinoid Oil Re[1]ning
- Pharmaceutical Product Recovery From Waste Streams
- Gelatin Production
- Concentration Of Sugar Solutions
- Sodium Hydroxide (Noah) Production
- Sulfuric Acid Production
- Phosphoric Acid Production

- Evaporative Crystallizers For Salts
- Brewery Waste Concentration Systems
- Chemical Recovery In Metal Plating processes

Fig 4.1.1 Evaporators

4.1.2 Machine Adjustment

Before allowing someone to start using any machine you need to think about what risks there are and how these can be managed.

Before starting any operation the operator should be check the main parts of the equipment appropriately and identify faulty and unfit parts or components of the machine then adjust and fit all parts or components of the machine identified based on operation procedure standards.

4.1.3 Safety check:

Safety check is very important to minimize hazards and risks on operator and to prevent machine damage.

Main parts of machine to check and make sure there is no foreign matter on:

- The conveyer belt
- Working table, and
- End sealing knives and there is no other person around the machine.

4.1.4 Switch on the power:

Open the door of the cabinet and connect the main breaker, close the cabinet, check to see if all thermostats and power supply indicator lamp on the control board are normal, and see if the display of the human-machine interface is normal.

4.2 Equipments

4.2.1 Heat exchangers

Heat exchangers are a leading global provider of equipment and system for the fruit and vegetables processing industry, from single machine to complete processing lines and turn –key plants.

Our complete range of fruit and vegetable processing equipment is engineered to achieve high volume or run in small custom batches as required, meeting global market

Our equipment provide the industry most innovative solution for improving efficiency, reducing operational sheets and maintaining the products organoleptic properties

4.2.2 The advantages of heat exchangers for fruit and vegetable processing include

- Little or no water consumption
- High energy recovery
- Vegetables are never exposed to the atmosphere
- Can be cleaned by CIP
- Low cooling temperatures are allowed

Fig 4.2.2.1 Corrugated Tube Heat Exchanger

4.2.3 The vapour separator removes entrained solids from the vapours, channeling solids back to the heat exchanger and the vapours out to the condensate

Complete vacuum keeps the product temperature low and the difference in temperatures high.

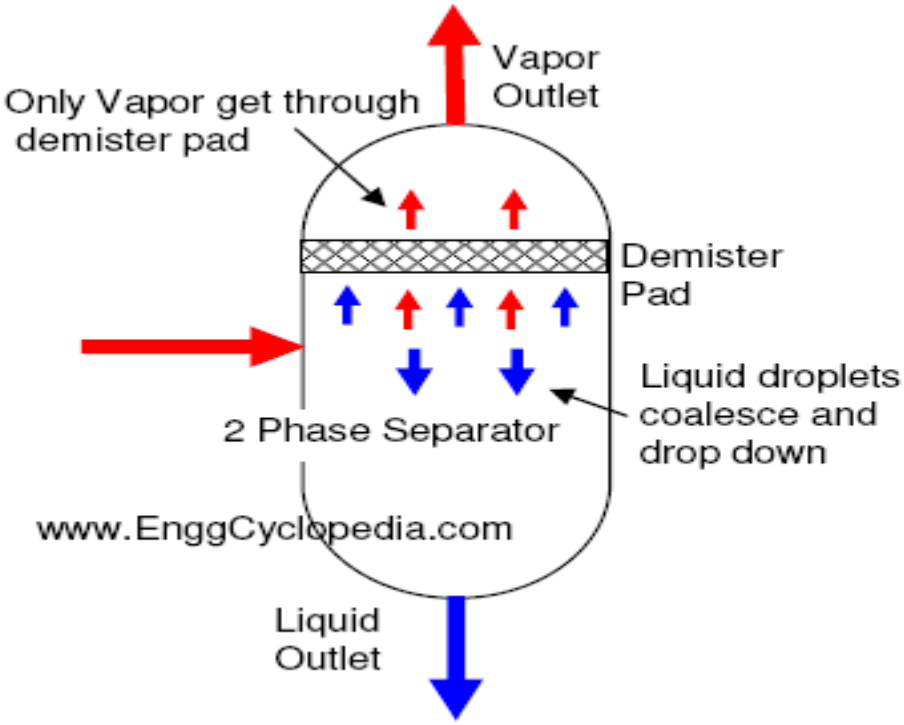

Fig 4.2.3.1 vapour liquid saparator

Fig 4.2.3.2 Vacuum vapour condenser

Self-check 4	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Instruction: Short Answer Questions (20 points)

1. What is evaporation technology? (5 points)
2. Write down specific application of evaporation system? (5 points)
3. What is safety check? (5 points)
4. What are heat exchangers? (5 points)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 5:- Carrying out pre-start checks

5.1 Carrying out pre start checks

In an industry, there are many types of works to be operated. For example: machine and laboratory operation. So before we are going to operate machine/lab equipment we have to inspect /check whether it is in a good operating condition or not. Checking conditions of operating equipment has a vital role for the operator's safety, quality of a product and also for equipment safety.

Operators always have to check the following before going to manipulate operations;

- Parameter setting (pressure, temperature, flow...)
- Identify faulty conditions.
- Analyze maintenance requirements.
- Identify hazards
- All these can be accomplished by investigating

5.2 Conduct Checks on Machine/Equipment

Before allowing someone to start using any machine you need to think about what risks there are and how these can be managed. So, you should:

- Check that it is complete, with all safeguards fitted, and free from defects.
- The term 'safeguard' includes guards, interlocks, two-hand controls, light guards, pressure-sensitive mats etc.
- By law, the supplier must provide the right safeguards and inform buyers of any risks ('residual risks') that users need to be aware of and manage because they could not be designed out.
- Produce a safe system of work for using and maintaining the machine.
- Maintenance may require the inspection of critical features where deterioration would cause a risk.

- Also look at the residual risks identified by the manufacturer in the information/instructions provided with the machine and make sure they are included in the safe system of work.
- Choose the right machine for the job.
- Make sure the machine/ equipment is:

✓ safe for any work that has to be done when setting up, during normal use, when clearing blockages, when carrying out repairs for breakdowns, and during planned maintenance;

✓ Properly switched off, isolated or locked-off before taking any action to remove blockages, clean or adjust the machine.

5.3 The Pre- and Post-Operation Equipment Inspection Checklist

a. Clear any accumulated debris from the equipment's.
b. Check signs of damage.
c. Check for leaking or pooled fluid around and under the machine.
d. Check for new signs of structural damage, scratches or dents on the machine.
e. Inspect the operator compartment and clear away any debris or obstructions.
f. Familiarize yourself with the control style and change as needed.
g. Identify auxiliary/attachment controls.
h. Start the power and review console indicators and warnings.
i. Review all external surroundings.

Self-check 5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction I: Short Answer Questions (10 points)

1. What are the things in which the machine operators will be always have to check just before going to manipulate operations? (5pts**)**
2. List and discuss in detail what you have to do during performing the Pre- Operation Equipment Inspection on a machine.(5pts)

You can ask you teacher for the copy of the correct answers.

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

LG #56	LO #2- Operate and monitor the evaporation process

Instruction sheet

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

- Starting and operating process
- Monitoring equipment
- Identifying and reporting variation
- Monitoring process
- Identifying and reporting out-of-specification product/process outcomes
- Maintaining work area
- Conducting work
- maintaining workplace record

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- The process is started and operated according to workplace procedures
- Equipment is monitored to identify variation in operating conditions
- Variation in equipment operation is identified and maintenance requirements are reported according to workplace reporting requirements

- The process is monitored to confirm that specifications are met
- Out-of-specification product/process outcomes are identified, rectified and/or reported to maintain the process within specification
- The work area is maintained according to housekeeping standards
- Work is conducted according to workplace environmental standards
- Workplace records are maintained according to workplace recordingrequirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
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6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go to operation sheet.

Information Sheet 1:- Starting and operating evaporation process

1.1 INTRODUCTION

Evaporation: - is one of the most important unit operations in processing industry . Large quantities of fruit and vegetable juices, sugar, and syrups are concentrated in several types of commercial evaporators.

In the concentration of many fruit juices and other heat sensitive materials, single pass evaporators are preferred, because the product quality is not damaged appreciably by the short time exposure to heat.

Evaporation: - that separates a liquid from solids by means of heat transfer via vaporization or boiling. The purpose of evaporation is to concentrate a solution of a non volatile solute (i.e. solids) and a solvent (i.e. liquid), which is typically water. Evaporating a portion of the solvent concentrates the solute into a more-viscous liquid product. Evaporation is regularly used in the food processing, chemical, Kraft paper, and pharmaceutical industries to produce liquid concentrates.

1.2 Definitions, Concepts, Operational, and Product Characteristics

When sourcing evaporation machinery, it's important to understand the terminology surrounding the processes and products. The following terms will help you foster an understanding of the evaporation process and the equipment used to facilitate it.

a) Heat Sensitivity. Some chemicals or food ingredients are altered by varying degrees of exposure to heat. If that is the case, evaporation temperatures can be reduced by

operating the system at lower pressures. Decreasing fluid volume and retention time of the process fluid inside the evaporator also benefits Products with sensitivity to heat.

b) Fouling. This term refers to a gradual build up of solid deposits on heat transfer surfaces. Initial signs of fouling are increasing operating pressures. Secondary indication of fouling is the increase in the steam pressure to the system. If ignored, fouling causes product “burn-on” on the heat transfer surface resulting in system shutdowns for cleaning and maintenance purposes.

c) Foaming. This is a common byproduct of the evaporation process. While potentially harmless, excess foam in the system will cause carryover of product to the system condensate. Ways to minimize the negative effect of foam include increasing tubular vapor velocity, spraying the solution onto the foam, or Adding an anti-foaming agent.

d) Boiling Point Elevation. At atmospheric pressure, water’s boiling point is 212° F. However, dissolved solids can increase the actual boiling point. Dissolved solids such as salt and caustic soda have a drastic impact on the boiling point. For example, the boiling point of 30% calcium chloride is 230° F at

e) Atmospheric pressure. Variations like this must be considered in the evaporator pressure and temperature profile.

f) Reactivity. Materials in the process of evaporation may sometimes be subject to chemical reactions at particular temperatures or concentrations. If these reactions are undesirable, it’s important to avoid the process conditions that will lead to those speci¹c circumstances.

g) Viscosity. Viscosity is a measure of film thickness, or a liquid’s resistance to deformation. Increases in liquid viscosity correlate to overall reduction in heat transfer coefficients. The configuration of a multiple effect system, as well as the setup of contracting methods, can optimize evaporator performance when dealing with high viscosity fluids.

h) Heat Transfer Fluid. Evaporators using steam to drive the evaporation process require less heat transfer area than hot oil-heated evaporators. However, if the target material undergoing the evaporation process is not heat sensitive, hot oil is often the better option, since the oil’s temperature can be higher than steam temperatures, reducing the required amount of overall heat transfer area for the system.

i) Shell Side Vapor Velocity. Evaporator tubes and heating jackets (the shell side of a tubular evaporation system) must pass vapor at precise velocities to bolster the elimination of non-condensable gas, or air, and promote the development of good vapor shear.

J) Wetting Rate. Lubrication of the process side heat transfer area in an evaporator is an essential design aspect of the evaporation process. This is especially true in a falling film evaporator. There must be a sufficient fluid to achieve a proper wetting rate. This wetting rate decreases the risk of fouling, as well as the buildup of solids on heat transfer surfaces.

1.3 Types of Evaporators

There are several varieties of evaporator designs commonly used throughout different industry sectors. The selection of the appropriate design is based on many factors that consider the efficiency of the system and the appropriate use of a specific evaporator type to maintain final required product characteristics.

Within the framework of the system design is the selection of the appropriate equipment within the design.

The main piece of equipment used at the heart of the evaporation process is the evaporative heat exchanger. The varied system designs can utilize different technologies within the evaporator system.

The two main technologies used in an evaporator design:

Tubular evaporators: A shell and tube heat exchanger is used to drive the evaporation process. The specific detailed design of the shell and tube results in a variety of evaporator system configurations that include:

- Falling Film Evaporator
- Rising Falling Film Evaporator
- Flash Evaporator
- Forced Circulation Evaporator

Plate evaporators: - As the name suggests, a plate evaporator uses a plate heat exchanger in the system design to drive the evaporation process. It offers several benefits over a tubular design.

- The plate heat exchanger is relatively easy to disassemble, inspect, and clean.

- Depending on the process fluids a higher heat transfer coefficient is achieved.
- The compact heat exchanger area reduces the overall system size and headroom requirement
- Lower installation cost

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction I: Short Answer Questions (15 points)

1. What is heat sensitivity? (5pts**)**
2. Write down two main technologies used in an evaporator design .(5pts)
3. _____ Is a piece of equipment used at the heart of the evaporation process.(5pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

Information Sheet 2- Monitoring equipment

2.1 Introduction

The evaporation monitoring system measures how much water evaporates from a class. An evaporation pan by measuring water level in an adjoining still level .the still level reduces the fluctuation in the pan's water level caused by wind.

2.2 Hygienic equipment design and gentle process treatment

Hygienic equipment design and gentle process treatment are necessary to get a high quality end product while avoiding contamination. The evaporation process and associated pre-heating has a significant impact on the desired functionality and microbiology of the powder. Using DSI (direct steam injection) we quickly move product from one temperature to another and cool it back down again with minimum damage to the product. Our knowledge of whey protein, lactose and calcium phosphate chemistries are critical in manipulating the process to ensure maximum efficiency and product quality. We help you get control over your evaporation process, and thereby also maximize the time between cleaning occasions.

Increasingly, we also use computational fluid dynamics (CFD) techniques to simulate trials, before carrying out physical tests in the pilot plant. CFD is also used to create an optimal line design with the minimum consumption of energy, water and other utilities

2.3 monitoring equipment operation

There are a few things that you should consider to identify and operate machines as these factors will affect its usefulness and working life.

Measuring machinery health by performance monitoring has the potential to give warning of a developing failure through the changing levels of a suitable parameter being measured, thereby indicating a change in condition of a component, machine or system.

2.3.1 Condition Monitoring and Process Analysis

Most machine and process characteristics which affect quality, availability, capacity, safety, risk and cost can be continually evaluated throughout an asset's lifetime. This is essential in identifying impending failure and will be applied to critical areas identified in the reliability plan.

The current state-of-health of process plant is important information related to current information, diagnosis and prognosis of various defects, and predicted useful life in the optimization of safety, quality and high production rates.

There are the obvious functions of monitoring and controlling the process for reasons of safety and product specification. Additionally, there is invaluable information to be gained from the process parameters that can give an understanding of the current health of the asset.

Condition Monitoring has historically focused on the acquisition and analysis of measurable parameters that would give useful information as to the condition of machine components and, hence, a forecast of the likely serviceability of the machine.

The wider view of Condition Management must take into account the performance of the machine, or the system of which it is a part, and report on excursions away from previously defined acceptable tolerances.

The definition of Condition Monitoring embraces the concept of Performance Monitoring also: The process of systematic data collection and evaluation to identify changes in the performance or condition of a system or its components, such that remedial action may be planned in a cost effective manner to maintain reliability.

The technology of Process Control allows access too much of the information needed to trend machinery and system performance parameters. These parameters are monitored and alarms set for out-of-tolerance conditions. This is particularly true for systems more so than individual machines—unless they are process critical and individual monitoring can be justified.

2.4 Applications for Machinery Performance Monitoring Machines and Systems for which Performance Monitoring

Surveys may be required on a routine basis include the following items:

- Pumps – due to impeller wear, seal ring wear (re-cycling) or blockage.
- Fan Systems – due to filter blockage, blade fouling or re-cycling.
- Boilers – due to loss of thermal efficiency for many different reasons.
- Heat Exchangers – due to fouling or blockage.
- Steam Turbines – due to blade fouling and numerous other reasons.
- Air Compressors – due to wear, filter blockage, valve leakage (reciprocating), etc.
- Diesel or Gas Engines – due to loss of compression (rings or valve leakage) etc.
- Electrostatic or bag dust filters – due to fouling, shorting or leakage

2.5 Performance Monitoring of Pumps: - a typical set of centrifugal pump curves is shown opposite. Pump manufacturers extensively test every pump on a calibrated test tank and produce accurate performance curves. A typical diagram giving the correct names for the parts of a centrifugal pump is also given.

For any given liquid the variables shown on these performance curves are as follows:

- Total Head (discharge minus suction) expressed as a vertical dimension (eg metres) or as pressure differential.
- Power Consumed (shaft power).

- Efficiency
- Flow
- Impeller Type
- Shaft Speed

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction I: Short Answer Questions (15 points)

1. What is heat sensitivity? (5pts**)**
2. Write down two main technologies used in an evaporator design .(5pts)
3. _____ is a piece of equipment used at the heart of the evaporation process.(5pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

Information Sheet 3- Identifying and reporting variation

3.1 Identifying Variation in equipment operation

3.1.1 Techniques of identifying equipment variations

- Assess quality of received components, parts or materials.
- Continuously check received components, parts, materials, information, service or final products against workplace standards and specifications for conformance.
- Demonstrate an understanding of how the received components, parts or materials, information or service relate to the current operation and how they contribute to the final quality of the product or service.
- Identify and isolate faulty components, parts, materials or information that relate to the operator's work.
- Record and/or report faults and any identified causes in accordance with workplace procedures.
- Follow machine manufacturers manual.

3.1.2 Steps of corrective action in response to variations

a. Define the Problem

Take time to adequately define the problem (who, what, when, why, where, how much and how often).

b. Interim/ Temporary Actions

Once a problem has been detected, the first priority should be to contain the problem, and prevent delivery to the customer. If already delivered, the customer needs to be notified to prevent further liability.

c. Root Cause Analysis

The key to resolving a problem is identifying the true root cause. There may be several underlying causes, a new operator, a change in procedure, or another 'rush job' circumventing the system. This is why it is important to find the root cause of the issue and define a permanent solution.

d) Permanent Actions

The process should be reviewed to arrive at a solution for correcting the root cause. This review should engage the 7 basic quality tools. The solution may involve longer term planning, requiring milestone dates, capital justification, training, and/or approval from the customer.

d. Verification

Checkpoints in the process should be created to verify effectiveness. This could be accomplished by inspection, internal audits, and/or measurement.

e. Control

If mistake proofing was not part of the solution, then a measurement to detect the root cause early should become part of the system. A procedural change should become part of the system by updating the work instruction and training for accountability. Consider putting a reaction plan in place should the problem reoccur.

f. Prevention

Very few organizations reach this step. For example, all the above steps are completed, yet the problem returns 6 months later. Perhaps, a new operator shows up who may have been qualified through 'On-the Job' training without verification of their competency. Or the filter was replaced as part of the solution, but it is dirty again and hasn't been placed on the Preventive Maintenance schedule.

Self-check 3	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction I: Short Answer Questions (10 points)

1. What are the techniques used in identifying equipment variations? (5pts)
2. Write Steps of corrective action in response to variations. (5 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

Information Sheet 4:- Identifying and reporting out-of-specification product/process outcomes

4.1 Introduction

The term OOS (out of specification), is defined as those results of in process or finished product testing, which falling out of specified limits.

The frequent occurrence of OOS (out of specification), results indicates that the manufacturing and analytical procedures not in control.

The consequences of OOS may result in market complaints, and rejection of commercial batches, which is an inventory loss for any processing industry. So, the OOS result occurrences have to be investigated and addressed. This article describes a typical procedure that can be adopted to handle OOS results.

The reasons for out of specifications can be classified as assignable and non-assignable. When the limits are not in specified, limits are called out of specifications. When out of specifications has occurred, the analyst should inform to quality control manager. Each out of specification will be identified with a unique identification number.

The out of specifications investigation involves 2 phases.

a. Phase I: (laboratory investigation)

The purpose of the laboratory investigation is to identify the cause for out of specification result. The reason for the out of specification may be defect in measurement process or in manufacturing process. Irrespective of the rejection of batches, the out of specification results must investigate for their trend. The investigation can be done to only those batches that are resulted in out of specification, or also to other batches and even other products associated with out of specification. The out of specification investigation should be thorough, timely, unbiased, well documented and scientifically sound.

b. Phase II investigation

When there is no possible outcome has obtained from the phase I investigation, the phase II investigation should be commenced/ started in context to investigate the errors occurred in manufacturing processes, sampling procedures along with other additional laboratory testing.

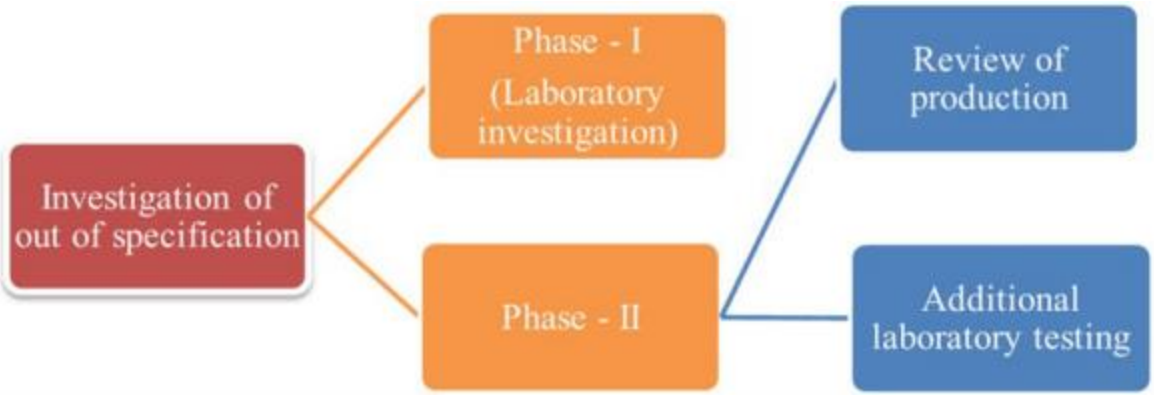

Fig 4.1. investigation of OOS (out of specification) results

s.no.	Parameter	Observation	Sign & date
1	check condition of the sample - Physical examination - Storage condition - Storage container - Labeling		
2	Check balance& its calibration - ID no. of balance: - Calibration due date:		
3	Check instrument calibration - Name of the instrument: - ID of the instrument: - Calibration due date:		
4	Check the reagent used for analysis - Raw data, physical appearance, validity of reagent used.		
5	Check the volumetric standard solution - Raw data, physical appearance, validity of standard solution used.		
6	Check the indicator solution - Raw data, physical appearance, validity of indicator used.		
7	Check for dilution, calculation, weighing, titer volume, readings		
8	Check working standard - ID, Raw data, physical appearance, validity of working standard used		
9	Check chromatograms and TLC plates		
10	Check glassware for its accuracy and calibration		
11	Check system suitability (HPLC / TLC)		

Fig 4.1.2 investigation of OOS (out of specification) results

Self-Check -4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short Answer Questions (10 points)

1. Define the term out of specification out comes? (5 points)
2. Mention and discuss the two phases of out of specification out comes? (5 points)

You can ask you teacher for the copy of the correct answers.

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

Information Sheet 5:- Maintaining work area

5.1. Type of Workplace

The workplace may be permanently fixed, mobile or even temporary based on one off work (promotional activities), seasonal work types, work involving one off situation with different duration (hours, days or weeks). The layout of the workplace is required to allow persons to enter and exit the workplace and move within safely, both under normal work conditions and in an emergency.

5.2. Maintaining work area

The work environment and facilities are required to be maintained in a safe and healthy condition, and need to be hygienic, secure and in a serviceable condition. This includes replenishment of consumables, repair of broken or damaged furnishings and equipment and ensuing cleanliness of these areas.

The layout of the work area should be designed to provide sufficient clear space between machines, equipment and fittings so workers can move freely without strain or injury also evacuate quickly in case of an emergency.

In determining how much space is required, the following should be considered:

- The physical actions needed to perform the task
- The need to move around while working
- Whether the task is to be performed from a sitting or standing position
- Access to workstations
- The equipment to be handled and the personal protective equipment that may be worn to perform the work.
- Environmental factors including heat or noise may require an increase to the space, as will work activities that involve manual tasks or the use of equipment.

Work area entry and exit

Entries and exits are required to be safe to allow impeded access and egress for all workers and visitors including those with special needs.

Generally the work place entry and exit should have:

- Entries and exits should be slip resistant under wet and dry conditions.
- Any walkways, boundaries or pathways shall be marked with 50mm wide with a contrasting color e.g. white or yellow
- Handrail should be provided on or at least one side of every staircase
- Separate entry and exits for mobile equipment.
- Power operated doors and gates should have safety features to prevent people from being stuck or trapped.
- Location of exits should be clearly marked and signs posted to show direction.

Floors and Other Surfaces

Floor surfaces shall be suitable for the work area and be chosen based on the type of work being carried out at the workplace, as well as the materials used during the work process, the likelihood of spills and other contaminants, including dust, chemicals, and the need for cleaning. In general, work area floor should be;

- Floors shall be free from slip hazards e.g. cables, uneven edges, & broken surfaces.
- Floor surfaces shall have sufficient grip to prevent slipping, especially in areas that may become wet or contaminated.
- Anti-fatigue matting, carpet, shock absorbent underlay, cushion backed vinyl shall be provided for workers where static standing occurs.
- Carpet shall be properly laid without loose edges or ripples and should be well maintained.
- Floors should be strong enough to support loads placed on them.

Workstations

Workstations should be designed so workers are comfortable undertaking their task and allow for a combination of sit and standing tasks. For tasks undertaken in a seated position, workers should be provided with seating that:

- Provides good body support, especially for the lower back.
- Provides foot support, preferable with both feet flat on the floor, otherwise a footrest shall be provided.
- Allows adequate space for leg clearance and freedom of movement.
- Is fully adjustable to accommodate different size.

Lighting

Sufficient lighting is required to allow safe movement around the workplace and to allow workers to perform their job without having to adopt awkward postures or strain their eyes to see.

The following factors are to be taken into account:

- The nature of the work activity.
- The nature of hazards and risks in the workplace.
- The work environment.
- Illumination levels, including both natural and artificial light.
- The transition of natural light over the day.

Air Quality

Workplaces are to be adequately ventilated which includes provision of fresh, clean air drawn from outside the workplace, uncontaminated from flues or other outlets and be circulated through the workplace. Workplace inside buildings may have natural ventilation, mechanical ventilation or air conditioning.

An air-conditioning system should:

- Provide a comfortable environment in relation to air temperature & air movement.
- Prevent the excessive accumulation of odors.

- Reduce the levels of respiratory by-products, especially carbon dioxide, and other indoor contaminants that may arise from work activities.
- Supply an amount of fresh air to the workplace, exhaust some of the stale air as well as filter and re circulate some of the indoor air.

Natural ventilation should consist of permanent openings, including windows and doors. Natural ventilation may be assisted by mechanical ventilation. Air-conditioning and other ventilation systems should be regularly serviced and maintained in accordance with manufacturer's instructions.

Welfare Facilities

Workers, including those who have particular needs or disabilities, must have access to the facilities provided.

Workers are to be provided with:

- Adequate breaks to use the facilities.
- Facilities which are within a reasonable distance from the work area.
- Shift workers have similar access to those who work during the day.
- A means of access which is safe.

Self-Check -5	Written test

Name…… ID…… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short Answer Questions (15 points)

1. Write factors to be considered in determining how much space is required. (5 points)
2. Mention points the work place entry and exit should have. (5 points)
3. Mention welfare facilities should be fulfilled in the work area? (5 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Information Sheet 6:- Conducting work

7.1 Conducting work in accordance with workplace guideline

Having a safe and healthy physical work environment, including amenities and facilities, is critical to eliminating and controlling risk in the workplace. This includes ensuring the work environment, facilities and amenities are compliant with legislative and other identified requirements. A safe work environment including:

- Facilities,
- Amenities or services and,
- Accommodations.

Facilities refer to toilets, washrooms, showers, lockers, dining areas, drinking water, etc. These facilities must be in good working order, clean, safe and accessible.

During conducting work, a person should ensure the following requirements;

- Legislative Requirements,
- Responsibilities,
- Need assessment,
- work environment,

✓ Welfare Facilities
✓ Inspect and Monitoring.

a. Legislative Requirements

A person conducting a business or undertaking at a workplace must ensure so far as is reasonably feasible, the following:

- The layout of the workplace allows, and the workplace is maintained, ,
- Work areas have space for work to be carried out without risk to health & safety,

- Floors and other surfaces are designed, installed and maintained to allow work to be carried out without risk to health and safety,
- Workers carrying out work in extremes of heat or cold are able to carry out work without risk to health and safety,
- Work in relation to or near essential services does not give rise to a risk.

b. Responsibilities

The Facilities Management Division is responsible for ensuring that workplace amenities and facilities:

- Are designed and installed according to company legislative and requirements
- Are inspected and maintained to ensure a safe level of hygiene.

Company Management and Supervisors: Management and supervisors of faculties, divisions and units are to ensure that amenities and facilities in the workplace do not expose workers, or visitors to health and safety risks.

c. Employees

Employees are responsible for reporting any identified hazard in the work environment, facilities or Amenities that they become aware of in accordance with factory or company guidelines.

d. Nature of Work Performed

The requirements of amenities and facilities will depend on the type of work being performed and the equipment being used. For example, persons handling chemicals or conducting hot and arduous activities may need to access shower and change room facilities.

e. Size and Location of the Work Area

Consideration should be given to the location such as the work area being in a building, remote area or outdoors. The work area may be multiple locations/sites over an extensive area.

f. The Composition of the Workforce

The workforce may be comprised of people of different sexes, religious beliefs and those people with special needs. This will influence the provision of amenities and facilities to accommodate the various needs.

Self-Check -6	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short Answer Questions (10 points)

1. Write things fulfilled in a safe working environment? (5 points)
2. Write work place requirements that the worker should be ensure when conducting the work? (5 points)

You can ask you teacher for the copy of the correct answers.

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

Information Sheet 7:- maintaining workplace record

7.1. Record Keeping Systems

There are certain written records or kinds of documentation that are needed in order to verify that the system is working. These records will normally involve the Implementing Hazard Analysis and Critical Control Point (HACCP) plan itself and any monitoring, corrective action, or calibration records produced in the operation of the Hazard Analysis and Critical Control Point (HACCP) system. Verification records may also be included. Records maintained in a HACCP system serve to document that an ongoing, effective system is in place. Record keeping should be as simple as possible in order to make it more likely that employees will have the time to keep the records.

The purpose of records

Accurate record keeping is essential to the application of a preventive control plan. Your records should be sufficient to enable you to confirm easily and with confidence that your preventive control plan is implemented and working effectively. Records can also help you improve your preventive control plan by providing a means for you to, for example:

- Identify the root cause of an issue
- Analyze and improve a process or procedure
- Identify gaps in training and in training needs

Self-Check -7	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short Answer Questions (10 points)

1. Write the purpose of recording? (5 points)
2. Mention makeup hazard analysis and critical control point plans. (5 points)

You can ask you teacher for the copy of the correct answers.

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

LG #57	LO #3- Shut down the evaporation

Instruction sheet

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

- identifying appropriate shutdown procedures
- shutting down procedures
- identifying and reporting maintenance requirement

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- The appropriate shutdown procedure is identified
- The process is shut down according to workplace procedures
- Maintenance requirements are identified and reported according to workplace reporting 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).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following
8. If your performance is satisfactory proceed to the next learning guide,

9. If your performance is unsatisfactory, see your trainer for further instructions or go to operation sheet.

Information Sheet 1:- identifying appropriate shutdown procedure

1.1 Identifying the appropriate shutdown procedure

Normal shutdown includes steps to render the systems safe, such as removal of hazardous process materials and inert (asphyxiating) gases. The systems might be cleaned as part of the shutdown; cleaning is often a process unto itself requiring its own set of startup, operation, and shutdown procedures.

1.2 The types of shutdowns

- Scheduled shutdown
- Maintenance shutdown
- Emergency shutdown
- Shut down to a standby condition.

1.2.1 Scheduled shutdown

A scheduled shutdown is initiated by the operator during normal operation of the unit when:

- Maintenance is required
- Feed supply is low or exhausted.

The shutdown procedure will depend on the type of equipment and the process chemistry.

Some steps taken in a unit shutdown may include:

- Shutting off the feeds to stop processes and heat generation particularly if processes are exothermic (produce heat)
- Re-circulating feeds from supply tanks so they do not enter the unit
- Shutting off heating or cooling to the unit or feed preheat system
- Shutting off mixing and other mechanical operations
- Cooling and flushing materials from the unit

1.2.2 Maintenance shut down

When maintenance to the unit equipment is required, the equipment may need to be entered so that work can take place.
The shutdown should be a scheduled or planned shutdown as per Standard Operating Procedures where equipment is:

- Isolated (process, mechanical and electrical)
- Cooled and depressurized
- Purged and gas freed
- Cleaned
- Gas tested on a continuous basis prior to and during entry.

A planned unit shutdown will prevent:

- Plugging of lines or equipment
- Possible damage to equipment
- Possible injury.

To prepare the unit for shutdown, the unit may need to be:

- Thoroughly drained and pumped out to remove chemical liquids
- Purged with steam or inert gas to remove vapors
- Solvent washed to remove deposits that build up on the equipment's internal surfaces

- Flooded with water or a solvent to remove any remaining chemicals any chemicals trapped in the unit must be flushed out.
- Isolated to prevent the entry of hazardous chemicals
- Drained
- Steam cleaned to remove remaining deposits.

During decontamination, regular sampling of the atmosphere inside a unit vessel is required to ensure toxic or explosive atmospheres do not build up inside the unit that could be a hazard to equipment or personnel. Gas testing must be carried out before anyone enters the vessel to ensure the atmosphere is not toxic, explosive or oxygen deficient.

1.2.2 Emergency shutdown

An emergency shutdown is initiated in the event of a fire, major spill, instrument failure, power failure, or total loss of control of chemical or physical processes. Emergency shutdown procedures must be followed during a shutdown sequence.

1.2.3 Shutting down to a standby condition

When a unit is to be shut down for a short period of time for maintenance on auxiliary equipment, the unit is shut down to a standby condition.

A standby shutdown allows a quick startup of the unit after maintenance is completed in order to minimize lost production time and offspec material. Standard Operating Procedures must be referred to when shutting down each type of unit to a standby condition.

A typical standby condition may include:

- Re-circulating material upstream and downstream
- Reduced heating or cooling (sufficient to maintain a safe process condition)
- Slow-rolling compressors
- Venting process gases to flare
- Diverting process streams to temporary storage.

Self-Check-1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short Answer Questions (15 points)

1. Write down types of shutdown? (5 points)
2. Explain emergency shut down? (5 points)
3. Write down advantage of planned unit shutdown? (5 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Information Sheet 2:- shutting down process

2.1 Shutting down the Process

The point of a shutdown is to create a plan for a complete cessation of all plant activities in order to perform necessary maintenance, repairs, equipment replacements, and to perform internal maintenance. The shut-down procedure is just as important as the start-up procedure for both an extruder and an injection molding machine. By properly shutting down the equipment, the start-up will be much quicker and most effective. Shut down the line can have a major impact on your capacity to restart production promptly. In an upcoming article, we will help you restart your machinery, taking the best steps and precautions.

Steps to follow for proper shutdown of manufacturing line;

a. End of production sequence

When pausing a manufacturing line, it is crucial to allow the machine to empty itself of all the components. The end of the production sequence clears the manufacturing equipment without loading new products into the cycle. This cycle finishes components in a machine and automatically removes most of the glue, parts, liquid, and powder from the production path. It may be necessary to remove these elements manually and thus completely empty the machine of any stray material that can complicate startup. This first step is crucial.

b. Air purge

Once the machine is out of service, the next thing we recommend is to purge any air that may be present in the equipment. Machines often use compressed air to activate the different cylinders, and most machines have an air purge valve that allows for bleeding off any accumulated air. It is important, because the air can crystallize and eventually wear out pneumatic components.

c. Cleaning of the machine

Beyond clearing the line of product and residue, purging air, and cleaning filters, you should take the time to clean the machinery thoroughly during shutdown. Cleaning now will avoid unpleasant surprises at startup.

d. Preventive maintenance

Whether the shutdown affects all of your manufacturing lines or just a portion, we recommend you use the disruption as an opportunity to perform preventive maintenance on your equipment. The manufacturer's operation and maintenance manual is the best source for guidance on how to care for your equipment and how to identify issues that need repair. Dealing with repair needs today will help you to be better able to restart quickly. It is also advisable to ensure that you have critical parts and components that need frequent replacement beforehand.

e. Environmentally stable

More generally, we suggest that you keep the equipment in a stable environment, adequate in terms of temperature and ventilation. This will help avoid degrading your production line. However, keeping the temperature and humidity level stable is important so that the machine does not start to rust.

As for air compressors especially air dryers and filters we highly recommend that you change these components at shutdown so there will be no contamination or blockage of filters. If you have just recently replaced filters, then you may not need to change to new filters at the time of the shutdown process. The main goal here is to avoid letting your machinery be dormant with dirty filters in place, as this could adversely affect the general functioning of your machine.

f. Protection

When your equipment is in an industrial environment, certain activities such as cutting materials, welding, generate dust and debris. This poses the risk of generating contaminants and damaging all that is mechanical, such as seals. Accumulated metal shavings, for example, can cause internal damage and pose a risk to operators when the machine is switched back on after the shutdown period. Normally, when the fans in the factory are running, dust or contaminants are filtered.

g. Get support

In case you are not comfortable with restarting, or if you have any questions, please do not hesitate to contact your partner company. You may even be able to ask them to reboot with you, online, video or phone. This crisis is unprecedented. Many factors are out of your hands, such as the duration of a shutdown period.

Self-Check-2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short Answer Questions (10 points)

1. What is the aim of shut down process? (5 points)
2. Write down Steps to follow for proper shutdown? (5 points)

You can ask you teacher for the copy of the correct answers.

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

Information Sheet 3:- identifying and reporting maintenance requirements

3.1 Identifying maintenance requirements

Maintenance can be defined as working on something to keep it in a functioning and safe state and preserving it from failure or decline. Maintenance procedures are written instructions that, when followed by the maintenance personnel, will ensure that equipment operates as designed within safe operating limits. Maintenance equipment may include;

- Sharpening the cutter
- cleaning,
- lubricating,
- Tightening
- Simple tool repairs and adjustments.

3.1.1Types of maintenance

a. Preventive or proactive maintenance

It is carried out to keep something functional. This type of activity is usually planned and scheduled.

b. Corrective or reactive maintenance

It is repairing something to get it working again and an unscheduled, unplanned task, usually associated with higher risk levels.

3.1.2 Routine maintenance tasks

It refers to On-going scheduled tasks that are performed in order to keep hand tools and basic equipment functioning properly. It could include tasks such as

- unblocking pipes and nozzles,
- sharpening blunt tools,
- cleaning nozzles on sprayers,

- checking, cables and plugs

Some tips on routine maintenance;

- Use the correct tool for the job.
- Keep tools in good condition.
- Cutting tools should be kept sharp.
- Use and maintain power tools according to their operator instructions.
- Make sure power tools are properly grounded or are double insulated.
- Wear appropriate personal protective equipment
- Keep all guards and shields in place.
- Unplug and store tools after use.

Table 1.1 maintenance check list

	Tool	Yes	No	Remark
1	Are tools in safe condition?			
2	Are instruction manuals available?			
3	Are power tools properly grounded?			
4	Are guards and shields in place?			
5	Is Personal Protective Equipment available?			
6	Are tools properly stored?			

If necessary;

- Tighten nuts and bolts.
- Smooth off splinters and sharp points.
- Tighten shafts.
- Unblock pipes and nozzles.
- Sharpen blunt tools.
- Clean nozzles on sprayers.
- Check and maintain cables and plugs.

3.1.2 Perform safe maintenance

Do maintenance safely:

- Always disconnect powered tools before servicing, adjusting, cleaning or repairing.
- Follow the manufacturer's instructions in user's manual for maintenance.
- Use appropriate tools and equipment while carrying out maintenance
- Test the functionality of the tool
- Replace all guards and safety devices
- Record your inspection and actions, sign out and pass the tool to the worker or store it safely

3.2 Reporting faults and problems

In order to report faults and problems, there should be maintenance schedule. Every work shop has a different maintenance schedule and it is important that you are familiar with the schedule implemented on the work shop where you work. A maintenance schedule assigns a specific date to specific maintenance tasks.

If faults are found, the tool must be sent for maintenance and the assigned person that fixes the tool has to report on exactly what was done and when it was completed.

An example of checklist is given below

Table 2.1 Maintenance schedule

Date	**Tool**	**Maintenance check points**	**Signature**	**Maintenance required**	**Signature**

Table 4.2 Examples for how to fill or document maintenance required and report performed maintenance is given below:

Date	**Equipment**	**Maintenance check points**	**Signature**	**Maintenance required**	**Signature**

Self-Check -3		**Written test**			

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction: Short answer questions (15 points)

1. Define maintenance and write what it may include? (5pts)
2. Mention and discuss the two types of maintenance? (5pts)
3. Define routine maintenance and write what it includes? (5pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

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AKNOWLEDGEMENT

We wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

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We would like also to express our appreciation to the TVET instructors and respective industry experts of Regional TVET bureau TVET College/ Institutes, **BEAR II UNESCO project and** Federal Technical and Vocational Education and Training Agency (FTVET) who made the development of this Teaching, Training and Learning Materials (TTLM) with required standards and quality possible.

This curriculum was developed on September 2020 at Bishoftu management institute

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The trainers who developed the learning guide