Fruit and Vegetable Processing Level II

Based on May 2019, Version 2 Occupational standards

Module Title: - Operating Water Purification Process

LG Code: IND FVP2 M06 LO (1-4)-LG (18-21)

TTLM Code: IND FVP2 TTLM 1020v1

October 2020

Table of Contents

LG #18	LO #1- Prepare the water purification equipment and 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
- Wearing and ensuring personal protective cloth
- Confirming available services.
- Completing batch records documentation
- Confirming processing parameter requirements.
- Checking and adjusting equipment performance
- Carrying out Pre-start check.

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:**

- confirm available materials to meet operating requirements
- Wear personal protective and ensure correct fit.
- Confirm and ready ***Services*** for operation
- Complete batch records or process documentation
- Entree and confirm processing/operating parameters as to meet safety and production ***requirements***
- Check Equipment performance and adjust as required.

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- Confirming available materials to meet operating requirements

1.1 Introduction.

Water purification is the process of removing undesirable chemicals, biological, contaminants suspended solids and gases from water. the goal is to produce water fit for specific purpose. Most water is purified and disinfected for human consumption.(dirking water),but water purification may also be carried out for a variety of other purpose including medical, pharmacological chemical and industrial application.

Titration Equipment – can be used to detect and measure the concentration of a substance within a liquid through acid/base titration. The addition of titrant of known concentration to a known volume of solution with unknown concentration can determine that unknown concentration through a reaction neutralization.

Refractometers – are devices that measure the angle of refraction from light that is passed through a liquid, gel, or solid substance and using that to establish parameters such as the salinity and sugar content

Chemical imaging (NIR/Raman) systems – devices that use analysis of samples by detecting and analyzing light that is in the near-infrared, visible, or near-ultraviolet light areas of the electromagnetic spectrum

Rheometers & Viscometers – are instruments that can measure the viscosity of a fluid and the behavior of fluids when shear or stress forces are applied to it. Having this information can reveal the properties of the fluid that relate to its structure and elasticity

Other equipment – additional equipment often employed in water quality applications includes.

- Conductivity meter
- Turbidity meter
- Comparator for chlorine determination using DPD reagents
- Analytical balance

- Water Distilling
- Steaming Water Bath
- Chlorine Titrimeter
- Centrifuge
- pH/ION Meter
- Autoclave
- Spectrophotometer
- Refrigerator -5CFT
- condenser
- Differential Pressure Regulator

- Personal Hygiene
- Water purification equipment, such as
- dosing equipment
- storage tanks
- pumps
- valves
- distillation systems
- reverse osmosis systems
- ultra filter
- sample testing (pH, TSS, any required quality parameters
- UV light
- Ozone generator
- deionisation plants
- emergency stop functions of equipment
- Temperature control

Figure 1: Spectrophotometer

Figure 1: Centrifuge

Figure 3: pH Meter

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 I: Choose the best answer (20 point)

1. One of the following are water treatment equipment

   A. Condenser B. Centrifuge C. Turbid meter. D. all

2. One of the following are not water treatment methods

   A. Distillation B. Deionization C. Reverse osmosis D .none

Test II: Short Answer Questions.

1. What are Rheometers & Viscometers?
2. Write down all water treatment laboratory equipment

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

Information Sheet 2- Wearing and ensuring personal protective cloth

2.1 Introduction

Appropriate clothing and footwear Appropriate clothing and footwear depends on work requirements. It should be designed to ensure that the body and clothing itself does not contaminate food or surfaces likely to come into contact with food.

Selection and use of PPE requires careful consideration, as there are many different types that reduce the risk of injury of contact or exposure to a hazard. Incorrect use of PPE, or purchasing inappropriate PPE, can contribute to serious workplace incidents.

2.2. The Requirement for PPE.

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

In general, employers are responsible for

- Performing a “hazard assessment” of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program.
- Properly wear PPE,
- Attend training sessions on PPE, Using personal protective equipment’s
- Care for, clean and maintain PPE, and.
- Inform a supervisor of the need to repair or replace PPE

The items listed below make up necessary basic clothing for all those employed on a treatmentwork

- muff,
- ear protection,
- eye and face protection,
- glove
- eye goggle
- safety shoes
- Apron
- Protective wear.
- Hair n net

Figure 4 personal protective equipments

All persons visiting or employed on a water treatment works should observe the following basic rules at all times:

- Do not smoke or use an open flame on the works except in those areas that have been designated as safe.
- Do not touch electrical equipment or switches and treat all equipment that has not been isolated and locked as live.
- Do not touch moving machinery.
- Take care when standing near or working over tanks and channels where there may be deep or swiftly moving water.
- Ensure all moving machinery parts are adequately guarded

SAFETY EQUIPMENT.

- Spark proof tools.
- Symbolic safety signs.
- First aid kit.
- Barricades, traffic cones, flashers and warning signs.
- Fire-fighting equipment to suit each area.

Basic rules

All persons visiting or employed on a water treatment works should observe the following basic rules at all times

- Do not touch electrical equipment or switches and treat all equipment which has not been isolated and locked as live.
- Do not touch moving machinery.
- Take care when standing near or working over tanks and channels, which may be deep or contain swiftly moving water.
- Do not enter the chlorination building without testing for a gas leak with a rag that has been soaked in ammonium hydroxide solution

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: Choose the best answer (20 point)

1. What are the most important methods of ensuring operator safety?

A. Appointing a safety officer and administrator

B. Alerting operators of unsafe acts and conducting mandatory safety training

C. Providing handbooks and copies of regulations

D. Working with proper light and ventilation

2. What are the two most important safety concerns when entering a confined space?

A. Corrosive chemicals and falls

B. Bad odors and claustrophobia

C. Extreme air temperatures and slippery surfaces

D. Oxygen deficiency and hazardous gases

3. What piece of safety equipment must an operator wear when entering a confined space?

A. Boots. B, Harness. C, Gloves. D, Goggles.

4. What safety measure must an operator follow prior to working on electrical equipment?

A. Lock out and tag out all electrical switches

B. Put on canvas gloves

C. Remove fuses from switch box

D. Tell one coworker not to turn on the switch

Note: **Satisfactory rating –≥ 1o points** **Unsatisfactory - below 10 points**

Information Sheet#3	Confirming available services

3.1 Introduction

Water treatment plants normally have a raw water intake, pumping and conveyance system and flow measurement. Although these systems do not provide any treatment, they are necessary as a part of the overall treatment process train. Water is used throughout the soft drink production process from sugar dissolving or con centrate. Dilution to blending in the final product. The degree of water treatment require d depends on thequality of the water supplied to the factory.

Treatment methods commonly include

- sand filtration to remove suspended solids,
- activated carbon filtration to remove colour and organic contaminants,
- UV treatment or ozonation to kill bacteria,
- micro filtration ('polishing') to remove particles and bacteria,
- and reverse osmosis (RO) membrane filtration to reduce dissolved solids. Water may also require softening by means of ion-exchange technique

3.2 Available Services for water purification or treatment process

The main ingredients in the operation of the water treatment plant are the chemicals for the flocculation process. These disappear with the settled solids to the wastewater treat ment plant where they form part of the remaining sludge. All filter systems (sand filter, c arbon filter, polishing filter and reverse osmosis membrane filters) need to be recovered , mostly through backwashing with clean water.

- Power
- water
- compressed air
- inert gas

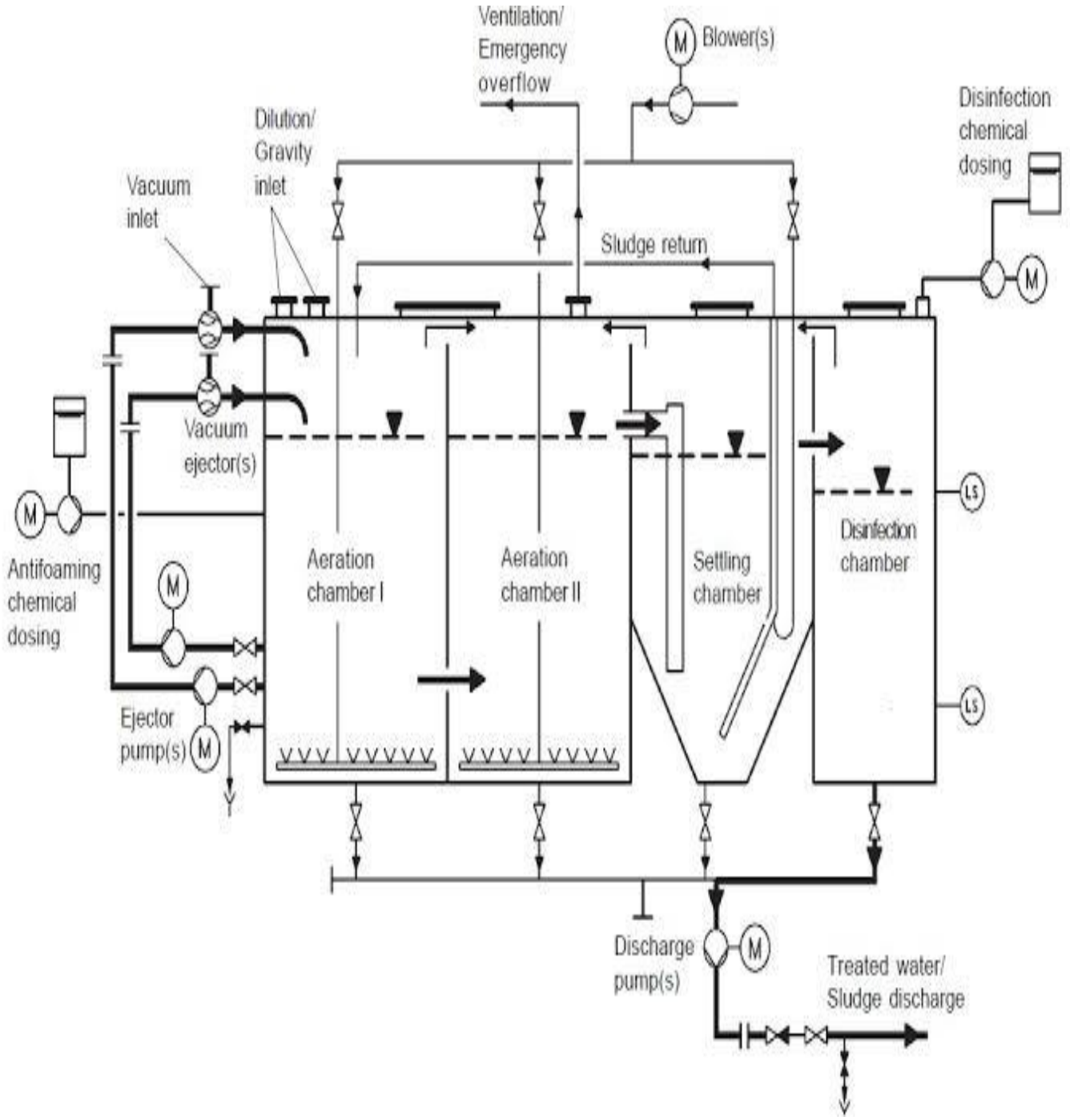


Figure 4: water treatment plant overview

Self-Check #–3	Written Test

Name…… ID…… Date…….

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

Test I: Choose the best answer (10 point)

1. Available Services for water purification are,

A/ Power C/ compressed air

B/ water D/ inert gas

E/ all F/ none

2. One of the following water treatment methods used to ozonation to kill bacteria.

A/. Sand filtration

B/. Activated carbon filtration

C/ UV treatment

D/. Micro filtration (‘polishing’)

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

Information sheet # 4	Completing batch records documentation

4.1 Introduction

Documentation is the key to GMP compliance and ensures traceability of all development, manufacturing, and testing activities. Documentation provides the route for auditors to assess the overall quality of operations within a company and the final product.

- **General requirements**

- Good documentation constitutes an essential part of the quality assurance system. Clearly written procedures prevent errors resulting from spoken communication, and clear documentation permits tracing of activities performed.
- Documents must be designed, prepared, reviewed, and distributed with care.
- Documents must be approved, signed, and dated by the appropriate competent and authorized persons.
- Documents must have unambiguous contents. The title, nature, and purpose should be clearly stated. They must be laid out in an orderly fashion and be easy to check. Reproduced documents must be clear and legible.
- Documents must be regularly reviewed and kept up-to-date. When a document has been revised, systems must be operated to prevent inadvertent use of superseded documents (e.g., only current documentation should be available for use).
- Documents must not be handwritten; however, where documents require the entry of data, these entries may be made in clear legible handwriting using a suitable indelible medium (i.e., not a pencil). Sufficient space must be provided for such entries.

- Any correction made to a document or record must be signed or initialed and dated; the correction must permit the reading of the original information. Where appropriate, the reason for the correction must be recorded.
- Record must be kept at the time each action is taken

There are various types of procedures that a GMP facility can follow. Given below is a list of the most common types of documents, along with a brief description of each.

1. *Quality manual*: A global company document that describes, in paragraph form, the regulations and/or parts of the regulations that the company is required to follow.
2. *Policies*: Documents that describe in general terms, and not with step-by-step instructions, how specific GMP aspects (such as security, documentation, health, and responsibilities) will be implemented.
3. *Standard operating procedures (SOPs)*: Step-by-step instructions for performing operational tasks or activities.
4. *Batch records*: These documents are typically used and completed by the manufacturing department. Batch records provide step-by-step instructions for production-related tasks and activities, besides including areas on the batch record itself for documenting such tasks.
5. *Test methods*: These documents are typically used and completed by the quality control (QC) department. Test methods provide step-by-step instructions for testing supplies, materials, products, and other production-related tasks and activities, e.g., environmental monitoring of the GMP facility.

   Test methods typically contain forms that have to be filled in at the end of the procedure; this is for documenting the testing and the results of the testing.

6. *Specifications*: Documents that list the requirements that a supply, material, or product must meet before being released for use or sale. The QC department will compare their test results to specifications to determine if they pass the test.

7. *Logbooks*: Bound collection of forms used to document activities. Typically, logbooks are used for documenting the operation, maintenance, and calibration of a piece of equipment. Logbooks are also used to record critical activities, e.g., monitoring of clean rooms, solution preparation, recording of deviation, change controls and its corrective action assignment.

4.2. Documentation system.

- Arrangements for the preparation, revision, and distribution of documents
- Necessary documentation for the manufacture
- Any other documentation related to product quality that is not mentioned elsewhere (e.g., regarding microbiological controls and product quality includes
    - specifications;
    - sampling procedures;
    - testing procedures and records (including analytical worksheets and/or laboratory notebooks);
    - analytical reports and/or certificates;
    - data from environmental monitoring, where required;
    - validation records of test methods, where applicable;
    - procedures for and records of the calibration of instruments and maintenance of equipment.

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: Choose the best answer (1o point)

1. What the most common types of documents

A. *Quality manual*

B. *Standard operating procedures (SOPs)*:

C. *Specifications*:

D. *Test methods*

E/ All

2. Documentation system includes

A/ specifications;

B/ sampling procedures

C/ Arrangements for the preparation, revision, and distribution of documents

D/ Necessary documentation for the manufacture

E/ ALL

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

Information Sheet 5- Confirming processing parameter requirements

5.1. Introduction

All water sources contain different inorganic and organic substances that must be removed during water treatment to produce water that is fit for domestic use. An integral part of the treatment train is the treatment and disposal of the substances that are removed from the water in the most cost effective and safest manner. To achieve this goal, a variety of treatment processes are utilized which employ various physical and chemical phenomena to remove or reduce the undesirable constituents from the water**.**

Appropriate unit processes can be combined into a process train for the desired level of treatment to meet the required water quality .The level of treatment may range from conventional treatment to remove turbidity, taste and odour and to disinfect the water to complete demineralization of the water.

5.2. parameters of water quality

The parameters commonly checked at inlet are

- TDS (Total dissolved solids),
- DO (Dissolved oxygen),
- BOD (Biological oxygen demand)
- COD (Chemical oxygen demand)
- Oil & grease
- **Turbidity** is the cloudiness of water .It is a measure of the ability of light to pass through water. It is caused by suspended material such as clay, silt, organic material, plankton, and other particulate materials in water.
- **Temperature** *Palatability, viscosity, solubility, odors, and chemical reactions are influenced by temperature*
- **Taste and odor** Taste and odor in water can be caused by foreign matter such as organic materials, inorganic compounds, or dissolved gasses
- **Solids** occur in water either in solutionr in suspension. These two types of solids can be identified by using a glass fiber filter that the water sample passes

through By definition, the suspended solids are retained on the top of the filter and the dissolved solids pass through the filter with the water.

- the chemical properties of the water (alkalinity and pH).

Self-Check #5	Written Test

Name……ID…… Date…….

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

Test I: Choose the best answer (5 point)

1. Which of the following is processing factor?
   A) The amount of suspended solids;
   B) The turbidity of the water;
   C) The nature of the suspended material;
   D) The chemical properties of the water (alkalinity and pH);
   E) The availability of facilities, trained operators and supervisors
   F) All

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

Information sheet #6	Checking and adjusting equipment performance

6.1. Introduction.

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.

Keyword

- Equipment performance monitoring.
- Equipment condition assessment.
- Equipment health monitoring

6.2 Condition Monitoring and Process Analysis

Most machine and process characteristics which affect

- availability
- capacity
- quality
- 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.

6.3 Checking Equipment Performance

Equipment's for which Performance Monitoring surveys may be required on a routine basis include the following items:

6.5. Poor operational practice is also one of the main causes of problems on treatment plants. It is imperative that operators understand why they are performing certain tasks and what the consequences are if the tasks are not carried out as prescribed. It is the responsibility of a treatment plant manager to ensure appropriate training of the operating staff

6.6. Lack of maintenance is the most common reason for plant failure. Mechanical equipment requires regular attention to ensure problem-free operation. Maintenance schedules must be strictly carried out. Good housekeeping and keeping equipment, buildings and civil structures clean and tidy go a long way to minimize operational problems. Work area, materials, and equipment are routinely monitored to ensure compliance with purification requirements.

materials handled and stored need to be monitor can include:

1. Gather the tools to clean in the designed area for cleaning.
2. Segregate the tools according to the kinds of dirty they have.
3. Submerge the tools in the washing pan.
4 Use paint brush to remove the dirty from the tools.
5 Get the tools from the washing pan and wipe them with rags until dart.
6 Clean and keep all materials used for cleaning

Self-Check #6	Written Test

Name……ID…… Date…….

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

Test I: Choose the best answer (10 point)

1/. One is the most common reason for plant failure

A/. Lack of maintenance

B/ Poor operational practice

C/ amount of suspended solids

D/ Taste and odor

2. Materials handled and stored need to be monitor can include

A/ Use paint brush to remove the dirty from the tools.

B/ Get the tools from the washing pan and wipe them with rags until dart.

C/ Clean and keep all materials used for cleaning

D/ Gather the tools to clean in the designed area for cleaning.

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

Information sheet # 7	Carrying out Pre-start checks

7.1 Introduction

It is important to carry out a series of checks before using a piece of machinery. This is particularly important in situations in which a number of people use the same machine. Larger companies and organizations usually have a system of checks, and a maintenance department that will deal with reported defects. Individuals working alone or in small teams will be responsible for checking and maintaining their own machines. Operator should be able to follow a checklist to ensure that they complete all the necessary checks

7.2. Pre-Start-Up Check procedures

- Corrosion resistant materials of construction are used for all equipment from the supply source to the membrane including piping, vessels, instruments and wetted parts of pumps
- All piping and equipment is compatible with designed pressure
- All piping and equipment is compatible with designed pH range (cleaning)
- All piping and equipment is protected against galvanic corrosion
- Media filters are backwashed and rinsed
- New/clean cartridge filter is installed directly upstream of the high pressure pump
- Feed line, including RO feed manifold, is purged and flushed, before pressure vessels are connected.
- Chemical addition points are properly located
- Check/anti-siphon valves are properly installed in chemical addition lines
- Provisions exist for proper mixing of chemicals in the feed stream
- Dosage chemical tanks are filled with the right chemicals.
- Provisions exist for preventing the RO system from operating when the dosage pumps are shut down

- If chlorine is used, provisions exist to ensure complete chlorine removal prior to the membranes.
- Planned instrumentation allows proper operation and monitoring of the pretreatment and RO system.
- Planned instrumentation is installed and operative.
- Instrument calibration is verified
- Pressure relief protection is installed and correctly set
- Interlocks, time delay relays and alarms are properly set
- pressure vessels are properly piped both for operation and cleaning mode
- Pumps are ready for operation: aligned, lubricated, proper rotation
- Fittings are tight
- Cleaning system is installed and operative
- Permeate line is open

Self-Check #7	Written Test

Name……ID…… Date…….

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

Test I: Give short answer.(10 point)

1/ List out pre start check procedures for water purification plant.

2/ what it means pre start check?

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

LG #19	**LO #2- Operate and monitor the water treatment purification 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 variation in equipment operation.
- Reporting maintenance requirements.
- Monitoring process to confirm purified and treated water.
- identifying out-of-specification process outcomes
- Maintaining work area

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**

- Start and operate process.
- Monitor equipment
- Identify variation in equipment operation and report maintenance requirements
- Monitor process to confirm purified and treated water.
- identify out-of-specification process outcomes
- Maintain work area housekeeping standards.

Learning Instructions:

Read the specific objectives of this Learning Guide.

1. Follow the instructions described below.
2. 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.
3. Accomplish the “Self-checks” which are placed following all information sheets.
4. 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).
5. If you earned a satisfactory evaluation proceed to “Operation sheets
6. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
7. If your performance is satisfactory proceed to the next learning guide,
8. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet-1	Starting and operating process

2.1 Introduction

What is water purification? Water purification is the transition of dirty harmful (Contaminated) water into clean safe water

To make water safe for drinking or for a specific purpose is the main target to purify the waste water. In Industries, treatments are used to remove unwanted constituents in water, and various methods are applied to remove contaminants like fine solids, pharmaceutical pollutants, and some soluble, insoluble impurities. The various methods used here for purification of water is commonly depended on the quality of water being, the cost of the treatment process and the quality standards expected for water.

2.2 Methods of water treatments.

There are many methods used in the purification of water from potable tap water to a standard suitable for use as a laboratory reagent. Here we will concentrate on five of the most commonly used technologies.

- Distillation
- Deionization
- Reverse osmosis
- Photo-oxidation
- Filtration
- Aeration
- Sedimentation.
- Coagulation and flocculation

1. **Screening**: To remove large parts such as sticks, plastic bags, woods, leaves, rubbish and other large particles which may create obstacles in the purification process. Water from ground level doesn't require any screening before other purification steps, as it is coming from the numerous rocky material.
2. **Storage**: Water from rivers is collected in a bank side reservoir and allows it for a period between a few days up to many months, so that to allow natural biological purification. This process may include slow sand filters. Storage reservoirs are allowed to use when river water is unfit or polluted.
3. **Pre chlorination**: There are certain microorganisms which are also said to be

fouling micro-organisms which grow in pipe work or in the tanks, so to minimize their concentration the water should be pre chlorinated. Excess chlorination is also dangerous as it may affect the quality of water.

4. **pH adjustment**: The pure water pH range is near to 7 that means (neither acidic nor basic). The seawater pH range is in between 7.5 to 8.4 (slightly basic). If the quality of water is found to be acidic (the range is below 7), then lime soda ash or sodium hydroxide should be added to reuse it further If the concentration of calcium ion increases in the water sample then the water become so hard i.e, it leads to increase the hardness of water. If we take water into alkaline condition may help in coagulation and flocculation process to work effectively and it also helps to minimize the risk of lead formation which is coming from lead pipes and from the lead soldier during fitting of the pipe. Iron pipes are corroded when comes in contact with moisture, which can be minimized by appropriate alkalinity. The calcium carbonate, which is formed in water can protect metal and reduce metal toxicity.

2.3 Unit processes for water treatment

Tars rack . Provided at the intake gate for removal of floating debris

Coarse screen. Mechanically cleaned screens provided at the intake gate or in the sump well ahead of pumps. Remove small solids

Micro strainer. Removes algae and plankton from the raw water

Aeration Strips. and oxidases taste- and odour-causing volatile organics and gases and oxidases iron and manganese. Aeration systems include gravity aerator, spray aerator, diffuser and mechanical aerator

Mixing. Provides uniform and rapid distribution of chemical and gases into the water

Flocculation. Flocculation causes aggregation of destabilized colloidal particles to form rapid-settling flocks

Sand filtration. Removal of flocculated and particulate matter by filtration through granular media (normally filter sand). Multi media may also be used (sand and anthracite, or sand and activated carbon, or a third layer may also be incorporated

Disinfection Destroys disease-causing organisms in water. Disinfection is achieved mainly by chlorine, but ultraviolet radiation and other oxidizing chemicals such as ozone and chlorine dioxide are also used

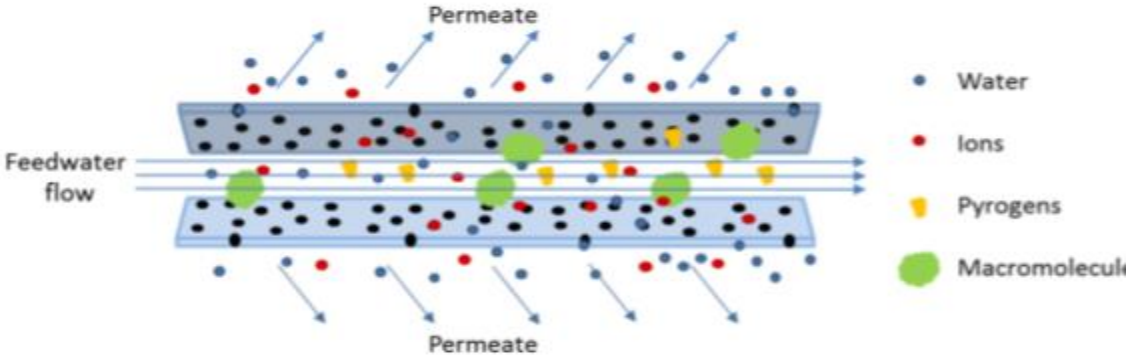
Chlorination Ammonia converts free chlorine residual to chloramines. In this form, chlorine is less reactive, lasts longer and has a smaller tendency to combine with organic compounds, thus limiting taste and odours and THM formation

Microfiltration (MF) Removal of all particulate matter and some colloidal matter

Reverse osmosis (RO) High-quality water permeates very dense membrane under pressure while dissolved solids and some organics are prevented from permeating the membrane. RO is also used for nitrate and arsenic removal.

Boiling: This is the oldest and effective way of purifying water as it eliminates most microbes causing intestinal related diseases. The water is boiled up to its boiling point to 100 Oc at normal pressure, but this process cannot remove chemical toxins or impurities. Since the heat resistant microbes are not intestine affecting, therefore, complete sterilization of water is not required for human health. The microbes start getting eliminated at temperatures greater than 60 0c, hence, it is advisable to boil water for a minimum ten minutes, for additional safety.

The boiling point does not affect the disinfecting process though it decreases with increasing altitudes. The bicarbonate ions are decomposed due to boiling resulting in partial precipitation of calcium carbonate, in areas where the water is very hard. Other solutes except calcium of higher boiling points than water are not removed by boiling, their concentration increases in the stored water, hence new pathogens may be found in water, if it has been stored for longer time



Reverse osmosis

Mechanical pressure is applied to an impure solution in order to force pure water through the semi permeable membranes. It is considered as the most important method for large scale of water purification; in a theoretical way. The semi permeable membranes are very difficult to form. Algae and other aquatic species colonize the membranes, so it should be well maintained. The term reverse osmosis is also called R. O, where minerals are separated by certain pressure through certain membranes called semi-permeable membrane. Not only ions, but also molecules and large sized particles are separated out through this method.

Distillations. In this method, water is boiled to produce water vapour.This water vapour when comes in contacts with cold surface, it condenses as a liquid. The solutes remain in the boiling solution as they are normally not vaporized. Also water is not completely purified by distillation process, as it may contain contaminants with similar boiling points and unvapouraised liquid droplets which are coming with the steam. However the distillation process can provide 99.09 %, pure water

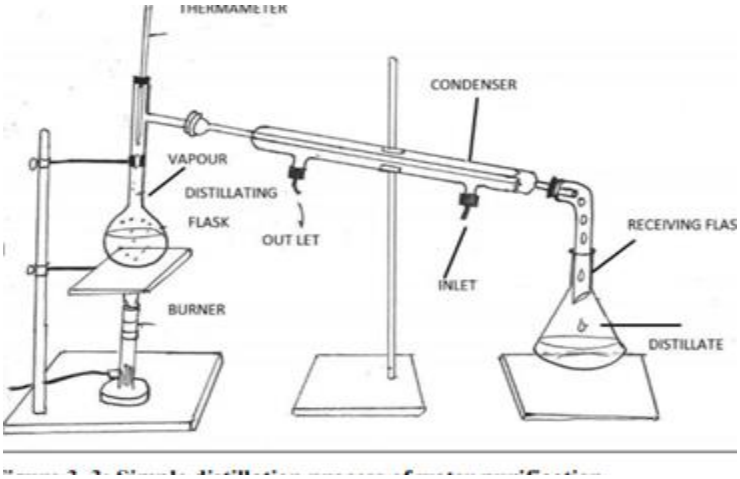


Figure 5: Distillations.

Photo-oxidation. Photo-chemical oxidation uses UV irradiation generated by a low pressure mercury lamp to kill microorganisms and ionize many organic molecules. The majority of the UV light is at 254nm and this performs the germicidal function. The UV light emitted at 185nm has sufficient energy to directly cleave organic bonds and also to generate hydroxyl radicals which react with organics to form organic acids and carbon dioxide. These can then be later removed from the water by ion exchange.

Filtration.

Three types of filtration are commonly used in water purification:

- Micro porous filtration uses a membrane of 0.2µm pore size which is capable of removing bacteria and particulate matter such as resin fragments from ion exchange columns.
- Ultrafiltration uses a membrane of typically 1-10nm. This is capable of removing pyrogens and other organic molecules with a molecular weight of >10,000Da such as proteins.
- Activated carbon filters remove chlorine and chloramine by adsorption and are also capable of removing some dissolved organics

Deionization. Also referred to as demineralization or ion exchange, deionization is a chemical process which removes ionic contamination. The feed water is passed over an ion exchange resin where cations react with the resin and release hydrogen ions and the anions release hydroxyl ions. These then combine to produce water molecules. Early deionizers had separate cation and anion resin beds but nowadays these resins are mixed together to form mixed bed deionizers.

Aeration. Air stripping is used for removal of volatile organics (e.g. solvents), carbon dioxide, disinfection by-products, some taste and odour causing compounds, and radon

Aeration processes are designed to achieve efficient mass transfer of oxygen into water and removal of gases and volatile compounds by air stripping. Oxygen transfer can usually be achieved using a simple cascade or diffusion of air into water, without the need for elaborate equipment. Stripping of gases or volatile compounds, however, may require specialized plant that provides a high degree of mass transfer.

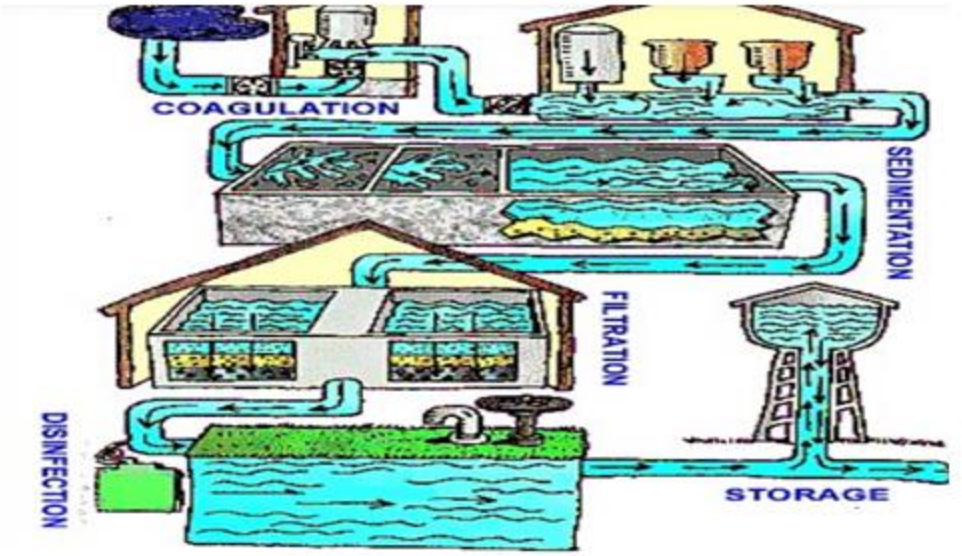


Figure 6: water Purification.

2.2. Purification Start-up Procedures

Start-up procedures help ensure your water is safe to drink after a partial or full system shutdown. Start preparing your water system to open at least one month before you plan to serve water to customers. Use this time to evaluate the condition of the water system, make repairs, disinfect, and ensure the water system is free of coliform bacteria, following the steps listed below.

1. **Review your Water Facilities Inventory form (WFI) and Inspect the Water System**

Inspect all components of your water system, including your distribution lines. Identify potential problems using the Small Water System Start-up Shut-down Self-Inspection Repair any deficiencies you identify before you serve water.

2. **Activate the source and treatment**.

Turn on the power to your pump and treatment equipment.

• Read and record the source meter on the checklist. If you don't have a source meter, arrange to have one installed as soon as possible.

• Measure the static water level in each groundwater source well. Disinfect the level probe, measure and record the result on the checklist. If you don't have a probe, ask your local health department if you can borrow one.

• Chlorinated systems: Purchase fresh chlorine, mix fresh feed solution, replace or clean all lines and parts, and verify the feed rate of the feed pump.

• Other treatment: Refer to the manufacturer, your written operating procedures, or call our regional engineer for instructions.

3. Operate the water system

• Run water through the entire water system by opening up hydrants, blow-offs, and faucets. Make sure all pressure tanks are pressurized and each valve opens and closes.

• If people have access to the water during the start-up process, notify them start-up is in progress and label accessible faucets as non-potable. If possible, disable accessible faucets during the start-up process.

Disinfect and flush

4. Disinfect and flush all sources, pressure tanks, storage tanks, and distribution lines. Refer to Emergency Disinfection of Small Systems* (331-242) for guidance. - If anyone could drink the water during the chlorination process, use 2 parts per million (ppm), and no more, of unscented household bleach (about ¾ cup) for every 1,000 gallons of water in the system. - If no one has access to the water, use 5 ppm of

unscented household bleach (about 1 ½ cups) for every 1,000 gallons of water in the system. - Leave chlorinated water in the lines for at least 24 hours. • Beginning with the tap closest to the source, flush all distribution lines thoroughly, away from all surface water such as lakes, streams, or ponds. Don't damage a pump by drawing water down below a pump intake level. If you have a storage tank, maintain 30 pounds per square inch of pressure in the lines.

5.Collect coliform samples

Measure the chlorine residual from taps or blow-offs throughout your distribution lines. You will need a chlorine residual test kit that measures from 0 to 3.5 ppm of "free chlorine." Untreated systems must not have any detectable free chlorine when coliform samples are collected. If you do detect chlorine, re-flush before collecting coliform samples. Chlorinated systems should have free chlorine residual at the "normal" operating level for the system (and greater than 0.2 ppm) when samples are collected.

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 I: Choose the best answer (15point)

1/ **Methods of water treatments.**

A/ Distillation

B/ Deionization

C/. Reverse osmosis

D/ Photo-oxidation

E/ Coagulation and flocculation

F/ all

3. **Commonly used types of filtration except one**

A/ Micro porous filtration

B/ Ultrafiltration

C/ Activated carbon filters

D/ Ae≥ration**.**

4. **Removes algae and plankton from the raw water.**

A/ Deionization

B/ Aeration.

C/ Photo-oxidation

D/ Micro strainer

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

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

Information Sheet-2	Monitoring equipment

2.1 Introduction

All instruments and control devices should be placed in readily accessible locations in order to facilitate observation, maintenance, repair, and replacement. Instruments should not be located in environments which might lead to premature failure of the instruments. Examples of such environments are areas subject to high temperatures or corrosive vapors. Provisions should be made for many of the instruments to actuate alarms if critical process variables exceed or fall below predetermined tolerable levels. Such alarms should include both audio and visual signals.

To simplify plant operations, the following guidelines should be observed during the processing stage.

- Unnecessary equipment and operations should be eliminated.
- Operations requiring frequent attention from plant operators should be located reasonably close together. The most attention is generally required for operation of filters, flocculators, and chemical feeding equipment.
- Chemical handling and feeding should also be simplified as much as possible. Unloading and storage areas for chemicals should be easily maintained and readily accessible and be close to the point of application of chemicals

2.2. Wastewater treatment plant performance evaluation.

- Department staff will consult with the plant operators to explain the program, the goals, the equipment used, and the expectations for participation.
- Upon arrival at the wastewater plant, Department staff will set up equipment, including meters capable of continuous, in-line monitoring for pH, Oxidation-Reduction Potential, Ammonia, Nitrates, Dissolved Oxygen, and other parameters.
- The Department will utilize the equipment to gather data on system performance, show the operator how to gather similar data, and explain the value of gathering

the data. We'll also explain how operators could choose to modify their treatment processes based on interpretation of the data collected.

- Although the Department may show operators how to achieve effective process control by using these process monitoring tools, the operators will continue to make all process control decisions, in conformance to their licensing requirements, and retain responsibility for those changes.
- The Department will also lend the facility additional laboratory equipment which will remain on site during the WPPE to assist in data collection and interpretation.
- During this time, the operator may need to spend more time performing routine testing at the treatment plant than was done previously. This will allow correlations to be made between process modifications and the process response.
- One major goal of the program is to provide the operator with the process monitoring knowledge and experience necessary to gather useful data and utilize it to make beneficial changes in the treatment process and the receiving stream long after the Department and its equipment have been removed
- During the evaluation, the Department will review monitoring records, laboratory sheets, operations log sheets, and any drawings and specifications for the treatment facility. Also of interest is data currently collected and how it is utilized for daily process modifications. This information is usually available from existing reports.

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: Choose the best answer (5 point)

1/ All instruments and control devices should be placed in

A/ readily accessible locations

B/ In order to facilitate observation

C/ located in environments which might lead to premature failure .

D/ All E/ None

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

Information Sheet-3	Identifying variation in equipment operation

3.1 Measurement of process variables.

In order to determine the degree of effectiveness of the different treatment processes, several physical and chemical parameters associated with water treatment must be measured. After they are measured, the information must be evaluated so that necessary adjustments can be made in the treatment processes.

Control. Water treatment plant processes may be controlled by manual, semiautomatic or automatic methods, which are defined as follows.

a. **Manual control**. Manual control involves total operator control of the various water treatment processes. The personnel at the water treatment plant observe the values of the different variables associated with the treatment processes, and make suitable adjustments to the processes.

b. **Automatic control**. Automatic control involves the use of instruments to control a process, with necessary changes in the process made automatically by the controlling mechanisms. When a process variable changes, the change is measured and transmitted to a control device which adjusts the mechanisms controlling the process. Automatic control systems have been developed which are reliable, but provision for emergency manual control must be included.

c. **semiautomatic control**. Semiautomatic control utilizes instruments to automatically control a function or series of functions within control points that are set manually. The operator manually starts the automatic sequence of operations. An example of semiautomatic control is the automatic backwashing of a filter after operator initiation of the program,

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: Short Answer Questions.(10 points)

1. List out water treatment plant controlling methods?
2. What are the Water pH determination procedures?

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

Information Sheet-4	Reporting maintenance requirements

4.1. Maintenance requirements.

Point-of-use water treatment equipment in general is not fit and forget technology and regular maintenance is essential to ensure the continued supply of safe drinking water. Equipment manufacturers' maintenance instructions must be followed as a minimum requirement. Ideally maintenance requirements should reflect the raw water quality and flow, but this is often not the case and instructions may be vague. Manufacturers' maintenance instructions may be based on the assumption that the equipment will be used to treat mains drinking water. Raw waters used for private supplies will always be of worse quality than public supplies and maintenance requirements quoted for treatment of feed water of potable standard will be inadequate. Maintenance requirements must be clear and the consequences of failing to maintain adequately should be highlighted. The majority of devices that fail do so as a result of inadequate maintenance.

Operation and maintenance of a water supply system refers to all the activities needed to run the system continuously to provide the necessary service. The two words are very frequently used together and the abbreviation 'O&M' is widely used. The overall aim of operation and maintenance is to ensure an efficient, effective and sustainable system (Castro et al., 2009). 'Efficient 'means being able to accomplish something with the least waste of time, effort and resources; 'effective' means being successful in producing the intended result; and 'sustainable' means able to be maintained at the best level over time – in this case, the supply of water.

Maintenance points to observe include:

When working with equipment and machinery (maintenance personnel), observe the following rules:

- Ensure that it cannot be started or operated by either disconnecting the means of starting or by isolation at the panel and/or the local stop.
- Always use the correct tools for the job.
- Before Keep chisels in good condition.
- Wear visors or goggles when grinding.
- Use the correct grade of protective visors or goggles when welding or brazing.
- Do not manhandle heavy objects. Use lifting gear.
- Always replace belt guards and other safety shields.
- Always read the carefully instructions carrying out any maintenance operation on specialized equipment

4.2. Preventative maintenance and operating procedures

- Perform jar tests on raw water samples when significant raw water quality changes occur.
- Adjust coagulant dosages and mixer speeds accordingly.
- Clean accumulated precipitate and sludge from rapid-mix and flocculation basins when need arises or at least every six months.
- Calibrate chemical feeders every month**.**
- High effluent turbidity or floc carryover may result from problems with the coagulation-flocculation process. Conduct jar tests to determine correct dosage and adjust dosages if necessary. Ensure correct functioning of mixing and coagulation processes
- High turbidity or flock carryover may also result from short-circuiting in the sedimentation basin. Perform tracer studies and make corrections. Possible corrective measures include installation of inlet baffles
- Test the solids content in the sludge withdrawal line daily
- Test turbidity of effluent on a regular basis and whenever the water quality or flow rate changes.

Corrective or breakdown maintenance: this is carried out when components fail and stop working. Breakdown is common in many utilities in Ethiopia and occurs as a result of poor preventive maintenance

Preventive maintenance: this is a regular, planned activity that takes place so that breakdowns are avoided. Examples of preventive maintenance would include servicing of equipment, inspecting equipment for wear and tear and replacing as necessary, cleaning and greasing moving parts of equipment, and replacing items that have a limited lifespan. Preventive maintenance is important because it ensures that the asset fulfills its service life. It also prevents crises occurring and costly repairs (in terms of time and money) being needed.

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: Choose the best answer (5 point)

1. Preventative maintenance and operating procedures**.**

   A/ Test turbidity of effluent on a regular basis and whenever the water quality or flow rate changes

   B/ Adjust coagulant dosages and mixer speeds accordingly

   C/ Test the solids content in the sludge withdrawal line daily.

   D/ All E/ None of the bove

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

Information Sheet-5	Monitoring process to confirm purified and treated water.

5.1 Introduction

In some cases it will be necessary to use raw water supplies containing unacceptably large concentrations of constituents that cannot be removed by conventional treatment processes. The most common of these objectionable constituents are mineral salts, such as sulfates and chlorides, and volatile organic compounds, (VOCs). Special treatment processes are necessary to remove these materials.

Demineralization. The presence of excessively high concentrations of dissolved minerals in water is indicated by high chloride (Cl-), sulfate (S042-), and total dissolved solids (TDS) levels. The recommended limits for these substances are 250 mg/L, 250 mg/L, and 500 mg/L, respectively

Removal of Volatile Organic Compounds. VOCs can be either halogenated naturally occurring organic substances (trihalomethanes), or synthetic organic compounds (SOCs). After the water quality requirements have been determined, treatment works will be designed using the appropriate treatment processes to meet these quality requirements. Most water quality requirements can be met through the use of treatment processes previously described.

pH adjustment: The pure water pH range is near to 7 that means (neither acidic nor basic). The seawater pH range is in between 7.5 to 8.4 (slightly basic). If the quality of water is found to be acidic (the range is below 7), then lime soda ash or sodium hydroxide should be added to reuse it further If the concentration of calcium ion increases in the water sample then the water become so hard i.e, it leads to increase the hardness of water.

5.2 Monitoring daily tasks in running a water treatment plant

- Check water meter readings and record water production.
- Check and record water levels in storage tanks.
- Check chemical solution tanks and record amounts used.
- Inspect chemical feed pumps.
- Check and record residual chlorine at the chlorine contact tank and in the distribution system.
- Inspect inlet pumps, motors and controls.
- Record inlet pump running times and pump cycle starts.
- Complete a daily security check

.

Self-Check -5	Written Test

Name……ID…… Date…….

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

Test I: Choose the best answer (10 point)

1/ In plant operations, the following guidelines should be observed.

A/ Unnecessary equipment and operations should be eliminated

B/ Operations requiring frequent attention from plant operators should be located reasonably close together

C/ A and B. D/ ALL

2/ Monitoring daily tasks in running a water treatment plant

A/ Check water meter readings and record water production.

B/ Check and record water levels in storage tanks.

C/ Check chemical solution tanks and record amounts used.

D/ Inspect chemical feed pumps

E/ All F/ None

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

Information Sheet-6	Identifying out-of-specification process outcomes.

6.1 Introduction

In order to evaluate the suitability of water for public supply purposes, it is necessary to have numerical quality guidelines by which the water may be judged. Drinking water standards are of primary concern but it is also valuable to have criteria for assessing the suitability of a source of raw water for providing water of drinking water quality after receiving conventional treatment. There are a number of collective water chemical parameters specific to water treatment. These include alkalinity, hardness, chemical stability, free available - and combined chlorine species

Alkalinity of water is a measure of its acid-neutralizing capacity

The **hardness** of water is determined by the concentration of divalent cautions in the water, mostly calcium and magnesium and is expressed as mg/l CaCO3. Hardness affects the lather-forming ability of water with soap.

The chemical stability of water is a very important characteristic since it determines whether water will be chemically stable, aggressive-corrosive or scale forming

Turbidity gives an indication of the concentration of colloidal particles in water.

The pH of water is measured in pH units. The pH value is a measure of the concentration of hydrogen ions, [H+] in the water expressed as a logarithmic value. The pH gives an indication of how acidic or basic the water is.

Reporting abnormal circumstances. Where abnormal circumstances may affect either the quality or quantity of the water supplied to consumers, senior management must be informed to allow them to take the necessary steps to alert consumers of the possible impact.

.

Self-Check -6	Written Test

Name……ID…… Date…….

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

Test I: Choose the best answer (5 point)

1. What are the out-of-specification process outcomes?

A/ The pH

B/ Turbidity

C/ Alkalinity

D/ The hardness

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

Information Sheet-7	Maintaining work area

7.1 Introduction.

Industrial good housekeeping is a term which is often not fully understood. However most be good housekeeping is just good common sense. Everyone is responsible for safety and means that all management and every employee should have an understanding of good housekeeping practice, and how it can help to prevent a large number of accidents at work.

Good housekeeping involves the maintenance of good lighting and heating, power supply lines, tools, machinery and the facilities for the efficient storage of materials and equipment. Removing of any loses items, particularly when working at height or on grating should be a permanent concern. It also means maintaining the necessary standards of domestic cleanliness and tidiness to provide safe, healthy and pleasant places in which to work and live. Among the from benefits to be derived good housekeeping are:

- Increased efficiency.
- The reduction of accident hazards.
- The reduction of fire hazards.
- Improved morale.
- Compliance with the law.
- Creating a favorable impression to people outside the Company.

Workshop should be kept neat and tidy. Good housekeeping can significantly reduce the risk of an accident and injury, failure to maintain a clean and tidy Workshop can result in accident and injury. Work areas and equipment are to be thoroughly cleaned after use.

Effective cleaning of all operational equipment is essential for good operational man agement and results. This is generally carried out by a cleaning unit which contains t he required cleaning solutions and controls the cleaning sequences

Self-Check -7	Written Test

Name……ID…… Date…….

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

Choose the best answer (5 point)

1/ What are the most benefits to be derived good housekeeping?

A/ Increased efficiency

B/ The reduction of fire hazards

C/ Improved morale.

D/ creating a favorable impression to people outside the Company

E/ All F/ None of the above

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

Operation Sheet 1- operating and monitoring water purification process

Procedures - for starting and operating purification process.

Step 1- wear personal protective equipment.

Step 2- set up all necessary equipment for operation.

Step 3- enter and setup processing parameter.

Step 4- start processing.

Step 5- check and confirm process purified and treated water.

LAP TEST	Performance Test

Name…… … ID…… date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each student to do it.

Task-1 starts the purification process.

LG #20	**LO #3- Shut down the water purification process**

Instruction sheet

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

- Identifying shut down procedure.
- Shutting down process .
- Preparing equipment for cleaning
- Completing batch documentation.
- Identifying and reporting maintenance requirements

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**:

- Shut down process.
- Prepare equipment for cleaning
- Complete batch documentation.
- Identify and report maintenance 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 “Operation sheets” ,
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 back to “Operation sheets”.

Information Sheet 1- Identifying shut down procedure

1.1. Introduction

Shut down/isolation means and includes isolation of mechanical, electrical drives, pipework (pressure) rotating equipment etc. utilizing electrical lock-off isolators, mechanical and power driven valves etc. in accordance with standard operating instructions. Relevant regulations

I. Shut-down sequence is undertaken safely and to standard operating procedures.
II. Machine/equipment is depressurized /emptied/de-energized/bled to standard operating procedures.
III. Safe shut-down of machine/equipment is verified.
IV. Safety/security lock-off devices and signage are installed to standard operating procedures.
V. Machine/equipment is left in clean and safe stat
VI. When working with tools at height makes sure they cannot fall
VII. Do not leave power tools switched on when disconnected from their power as unexpected starting will occur when power is re-connected.
VIII. Ensure that cables, power lines, pipes and hoses are not allowed to trail across gangways or work areas
IX. Check insulation, switches and fuse boxes for possible hazards. Ensure warning signs are clear and easily seen.
X. Ensure that correct type of firefighting equipment
XI. Remove empty cartons, wrappings and other flammable waste as soon as possible

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 I: Choose the best answer (5 point)

1/ Relevant regulations for shut down water treatment equipment

A. Shut-down sequence is undertaken safely and to standard operating procedures.
B. Machine/equipment is depressurized /emptied/de-energized/bled to standard operating procedures.
C. Safe shut-down of machine/equipment is verified.
D. Safety/security lock-off devices and signage are installed to standard operating procedures.
E. Machine/equipment is left in clean and safe status. F/ All

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

Information Sheet 2- Identifying shut down process

2.1 Shutting down process Steps are:

- Reading, interpreting and following information on written job instructions, specifications and other applicable reference documents.
- checking and clarifying task-related information
- Entering information onto preforms and standard workplace forms.
- Shutting down machine/equipment.
- Purging/de-energizing equipment.
- Installing safety/security lock-off devices and signage

2.2 Water treatment shutting down process requirements:

- TSS 5 microns size shouldn't exceed 1 mg/l;
- Turbidity – not more than 1 NTU;
- Oxidation – not more 5 mgO2/L;
- Content of active chlorine, organic solvents and strong oxidizers (ozone, bromine, iodine) – not less than 0,1 mg/l;
- Content of solved aluminum – less than 0,1 mg/l (less than 0,05 mg/l in case of silicon presence);
- Content of dissolved iron – less than 0,3 mg/l (less than 0,05 mg/l in case of silicon presence);
- Content of manganese – less than 0,1 mg/l;
- Content of cationic polymers and cationic surfactants – less than 0,1 mg/l;

Excess of any parameter can cause warranty obligations cancelation.

2.3 Shut-Down Procedures

1/Evaluate the water system

- ✓ Inspect the water system using the Small Water System Start-Up Shut-Down Self Inspection

2/Drain and repair the storage tank

- ✓ Drain all water out of the storage tank or reservoir.
- ✓ Inspect the tank for cracks and make any needed repairs

3/ Pressure tanks

- ✓ If there is a potential for freezing, drain your pressure tank(s) when not in use..

4/ Shut down the source(s

- ✓ Turn off the power to all treatment systems.
- ✓ Discard unused chlorine solutions and stock

5/Shut down treatment

- ✓ Turn off the power to all treatment systems.
- ✓ Discard unused chlorine solutions and stock

6/ Protect the distribution system**.**

- ✓ Do not leave taps open in the off-season.
- ✓ Never use anti-freeze in your water system because it is a health hazard.
- ✓ Exercise valves and ensure they're working. Repair if needed.

7/ When your system is closed

- ✓ Compile your operations and water quality records for the year. Note periods of peak water use, any water quality problems, and unexpected events. Use this information to plan for next year.

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: Choose the best answer (10 point)

1/ Shutting down procedures

A. checking and clarifying task-related information
B. entering information onto preforms and standard workplace forms.
C. shutting down machine/equipment.
D. purging/de-energizing equipment
E. All F/ None

2/ Water purification process Shutting down requirements includes all except

A/ TSS 5 microns size shouldn't exceed 1 mg/l;
B/ Turbidity – not more than 1 NTU;
C/ Oxidation – not more 5 mgO2/
E/ All F/ None of the above

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

Information Sheet 3- Preparing equipment for cleaning

3.1 Introduction

Pre cleaning, by removing heavy accumulations of soil and debris with appropriate tools, will save water during later washing operations. Effective cleaning to eliminate invasive species materials and prevent their spread can be accomplished by thoroughly removing soil and debris using pressurized water. In certain situations, cleaning with compressed air, rather than water, could prevent damage to certain equipment areas such as engine wiring systems and vehicle cabs.

3.2 Good Workshop Housekeeping

- Workshop should be kept neat and tidy.
- Work areas and equipment are to be thoroughly cleaned.
- Ensure that gangways, access routes and exit ways to fire exits are kept clear.
- Keep access to fire and emergency equipment clear at all times. Fire doors must never be locked or be difficult to open.
- Keep gangways and exit ways clear of rubbish; do not use them as storage area even on a temporary basis.
- Avoid tripping hazards such as boxes, trolley handles, trucks and materials protruding into gangways and exit ways.
- Ensure that there are no bumps or holes in the surface of gangways and exit ways which could cause a fall.

Effective cleaning of all operational equipment is essential for good operational manage ment and results. This is generally carried out by a cleaning unit which contains the req uired cleaning solutions and controls the cleaning sequences

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: Choose the best answer (5 point)

1/ Workshop Housekeeping

A/ Work areas and equipment are to be thoroughly cleaned.

B/ Ensure that gangways, access routes and exit ways to fire exits are kept clear

C/ Workshop should be kept neat and tidy

D/ Keep gangways and exit ways clear of rubbish; do not use them as storage area even on a temporary basis

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

Information Sheet 3 Completing batch documentation

3.1 **Introduction**

The key to GMP compliance and ensures traceability of all development, manufacturing, and testing activities. Documentation provides the route for auditors to assess the overall quality of operations within a company and the final product

Good documentation constitutes an essential part of the quality assurance system. Clearly written procedures prevent errors resulting from spoken communication, and clear documentation permits tracing of activities performed. Must be designed, signed, and dated by the appropriate component and authorized persons. must have unambiguous contents. The title, nature, and purpose should be clearly stated. They must be laid out in an orderly fashion and be easily to check.

Documents provide written information about policies, processes, and procedures.

Characteristics of documents are that they

- communicate information to all persons who need it, including laboratory staff, users, and laboratory management personnel;
- need to be updated or maintained;
- must be changed when a policy, process, or procedure changes;
- Establish formats for recording and reporting information by the use of standardized forms. Once the forms are used to record information, they become records. Some examples of documents include a quality manual, standard operating procedures (SOP), and job aids.

Records are the collected information produced by the laboratory in the process of performing and reporting a laboratory test.

Why are documents important?

Documents are the essential guidelines for all of the industry operations. Some of the important documents that every industry should have include

- Quality Manual—This is the overall guiding document for the quality system and provides the framework for its design and implementation. A industry is required to have a Quality Manual for ISO accreditation
- Standard Operating Procedures (SOP)—SOP contain step-by-step written instructions for each procedure performed in the industry. These instructions are essential to ensure that all procedures are performed consistently by everyone in the laboratory

Documents shall

- be designed, prepared and laid out in an orderly fashion
- be written in detail and in simple language that can be easily understood by the user have unambiguous contents
- have title, nature and purpose shall be clearly stated
- be regularly reviewed and kept up to date
- prevent inadvertent use of superseded documents, when they have been revised
- be approved, signed and dated by an authorized person
- be distributed with care

Self-Check -3	Written Test

Name: ……..ID…… Date: ……

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

Test I: Choose the best answer (5 point)

1 Documents shall be

A. be designed, prepared and laid out in an orderly fashion
B. have title, nature and purpose shall be clearly stated
C. be regularly reviewed and kept up to date
D. be approved, signed and dated by an authorized person .
E. ALL

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

Information Sheet -4. Identifying and reporting maintenance requirements

4.1 INTRODUCTION.

It is impossible to list all the possible operational problems that could arise at a water treatment works. Lack of maintenance**:** is the most common reason for plant failure

Mechanical equipment requires regular attention to ensure problem-free operation. Maintenance schedules must be strictly carried out and conduct routine maintenance.

The main problem areas are related to.

- poor design,
- Variations in raw water quality,.
- lack of maintenance,
- inadequately trained operators,
- inadequate process monitoring,
- poor record-keeping and poor management

Preventative maintenance and operating procedures that are necessary to ensure satisfactory operation.

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: Choose the best answer (5 point)

Choose the best answer (6 point)

1. What is the primary purpose of a preventive maintenance program?

A. Increase the use of backup equipment

B. Correct equipment breakdowns

C. Eliminate inventory of spare parts

D. Avoid future equipment problems

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

Operation Sheet 2- Shutting down process

Procedures for - Shutting down process.

Step1- wears personal protective equipment.

Step 2- Evaluate the water system

Step 3- Drain the storage tank

Step 4-Drain Pressure tanks, when not in use

Step5-Shut down the source, Turn off the power to all treatment systems

Step6- Shut down treatment discards ,unused chlorine solutions and stock

- ✓ Turn off the power to all treatment systems.

Step7- Protect the distribution system**,** do not leave taps open in the off-season

- ✓ Never use anti-freeze in your water system because it is a health hazard.
- ✓ Exercise valves and ensure they're working. Repair if needed.

LAP TEST	**Performance Test**

Name…… …….. ID…….. date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 – **Shut down process**

LG #21	**LO #4- .Record information**

Instruction sheet

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

- Conducting work.
- Maintaining work place records
- Recording Workplace information.
- Signing all records.
- Communicating record information.
- Keeping workplace information records.

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**:

- Conduct work.
- Maintain work place records
- Record Workplace information.
- Sign all records.
- Communicate recorded information and keep it in appropriate place.

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 “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,

Information Sheet 1- Conducting work.

4.1 Introduction

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.

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.

Also, make sure you identify and deal with the risks from:

- ➢ Electrical, hydraulic or pneumatic power supplies;
- ➢ Badly designed safeguards. These may be inconvenient to use or easily overridden, which could encourage your workers to risk injury and break the law. If they are, find out why they are doing it and take appropriate action to deal with the reasons/causes.

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 I: Choose the best answer (5 point)

1/ Make sure the machine/ equipment is

A/ Electrical, hydraulic or pneumatic power supplies

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

C/ 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

D/ A and B C/ B and C

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

Information Sheet 2- Maintaining work place records

2.1 Introduction

Records are observations, measurements, and other data recorded manually or by means of monitoring equipment, to document the devotion to critical limits or other processes requires

Records are the collected information produced by the industry in the process of performing and reporting industry operation.

Characteristics of records are that they:

- Need to be easily retrieved or accessed;
- Contain information that is permanent, and does not require updating.

All Records should be

i. legible and clear;
ii. Dated;
iii. readily identifiable and retrievable;
iv. carry authorization status;
v. retained for a designated period;
vi. protected from damage and deterioration while storage.
vii. All calculations should be duly recorded

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: Choose the best answer (4 point)

1/ All Records should be

A/ legible and clear.

B/ Dated.

C/ readily identifiable and retrievable.

D/ Carry authorization status.

E/ Retained for a designated period.

F/ Protected from damage and deterioration while storage.

Note: Satisfactory rating - 4 points Unsatisfactory - below -4 point

Information Sheet 3- Recording Workplace information

3.1 Introduction.

Records are observations, measurements, and other data recorded manually or by means of monitoring equipment, to document the devotion to critical limits or other processes requires.

Records are a tool used to confirm that things are working effectively. Records can:

- Provide a means to track/path and review deviations
- Identify the root cause of an issue
- Help improve a process
- Identify trends/tendencies indicating that a process is moving towards deviation

3.2 Production Batch Records

Documentation is the electronic or written record of all information regarding methods, conduct, and/or results of industry work; the factors affecting results of industry work; and the regular or corrective actions taken

Batch records should include documentation that each significant step in the production of the batch was accomplished including;

- Specific identification of each batch, including materials used during manufacturing, reagent record.
- Identity of major equipment used;
- COA records
- COA records
- Equipment log.

Good records enable one to track all activities performed during batch manufacture, from the receipt of raw materials to the final product release; they provide a history of the batch and its distribution. It is an essential part of GMP to keep accurate records,

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: Choose the best answer (10 point)

1. Batch records should include.

   A/ COA records

   B/ COA records

   C/ Equipment log

   D/ Labeling log

   E/ Packaging log

   F/ All.

2/ Records are a tool used to confirm and can

   A/ Provide a means to track/path and review deviations

   B/ Identify the root cause of an issue

   C/ Help improve a process

   D/ Identify trends/tendencies indicating that a process is moving towards deviation. E/ All

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

Information Sheet 4- Signing all records

Required Signatures:

- The initials or signature of the person who performs each test and the date the tests were performed;
- The initials or signature of a second person verifying for accuracy, completeness, and compliance with established standards
- The initials or signature of a person (supervisor/QA) reviewing the document.

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: Choose the best answer (5 point)

1. What is signature means?

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

Information Sheet 5- Communicating record information

5.1 Definition

Communication is the transfer of facts, ideas, opinions, feelings and information from one person or group to another. It is how we come to know and understand everything around us.

5.2 Operator communicate and seeking advice from supervisor to fulfil the job ≥

- How to collect samples and conduct tests
- How to Take corrective action.
- operational health and safety (OHS) hazards and controls
- common causes of variation and corrective action required
- Good Manufacturing Practice (GMP
- inspection or test points (control points) in the water purification process
- basic operating principles of process control .

basic operating principles of equipment, such as:

main equipment components

- Workplace information such as;
  - Standard Operating Procedures (SOPs)
  - specifications
  - production schedules and instructions
  - manufacturers' advice
  - standard forms and reports
  - critical control points

Self-Check -5	Written Test

Name: ……..ID…… Date: ……

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

Test I: Choose the best answer (5 point)

.

1. which one of the following is Workplace information

   A, Standard Operating Procedures (SOPs)

   B/, manufacturers' advice

   C/ manufacturers' advice

   D/ standard forms and reports.

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

Information Sheet 6- Keeping workplace information records

6.1 Introduction

Any records keeping system should be accurate, reliable, easy to follow, consistent as the basis used and be very simply.

Record keeping is the seventh principle of hazard analysis critical control point (HACCP) system. A simple recordkeeping system can be effective and easy communicable.

Record must be kept at the time each action is taken and in such a way that all activities concerning the conduct manufactures and control products are traceable /noticeable.

6.2 RECORD KEEPING AND REPORTING

Records must be kept to allow proper plant management and control. Performance records are required for trouble shooting, to identify changes in operating conditions, to identify reasons for process failure or water quality reduction, for process optimisation, to record changes in influent quality and process conditions, etc. A further important aspect of recordkeeping is the availability of data and information for research and design of future expansion to the facility or erection of new facilities using the same raw water resource.

Process flow charts, operating and maintenance manuals and the plant design philosophy should be accommodated in the documentation system. These documents should be available to the relevant personnel and specific requirements must be included in the operating philosophy. Any modifications to the plant must be recorded and the engineering drawings and process flow charts must be updated accordingly.

The mere recording of data without a systematic retrieval system associated with it is a wasted effort. The data must be stored in a system from where it can be readily retrieved and where it is securely stored

The time that data is stored is a critical part of the management of the record keeping system. This should be based on the purpose that the data is to be used for while

legislative requirements must be considered as well. Cognizance must be taken of the requirements of the water use permit or license regarding data availability and requirements by the authorities before deciding on the time that historical data is to be kept for.

Operating personnel should routinely record only that information that is useful in plant operation and troubleshooting.

The following data should be recorded as a minimum by the shift personnel:

- Flow-rate: influent, sludge scouring, filter backwash, chemicals dosage, water production
- Pressure: pump inlet and outlet
- Number of filters in operation, filtration rate, number of filters washed
- Chemical parameters: record all on-line and in-line monitor results. Important aspects in this regard are pH, conductivity, disinfectant concentration etc.
- Physical parameters: record all on-line and in-line monitor results, here turbidity (both inlet and outlet) and temperature are to be recorded

Self-Check -6	Written Test

Name: ……..ID…… Date: ……

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

Test I: Choose the best answer (5 points)

1/ which one following data should be recorded as a minimum by the shift personnel:

A/ Flow-rate: influent, sludge scouring, filter backwash, chemicals dosage, water production

B/ Pressure: pump inlet and outlet

C/ Physical parameters: record all on-line and in-line monitor results, here turbidity.

D/ Number of filters in operation, filtration rate, number of filters washed

E/ All

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

REFERENCE BOOKS.

1 . American Water Works Association (1999) Water quality and treatment: A handbook of community water supplies McGraw-Hill Inc.
2. American Water Works Association, American Society of Civil Engineers (2005) Water treatment plant design McGraw-Hill Inc.
3. Quasim SR, Motley EM and Shu G (2000) Water works engineering Prentece Hall.
4. Binnie C, Kimber M and Smethurst G (2002) Basic water treatment IWA Publishing.
5. Cotruvo JA, Craun GF and Hearne N (1999) Providing safe drinking water in small systems Lewis Publishers
6. Degremont (1991) Water treatment handbook Lavoisier Publishing.
7. Hammer MJ (1986) Water and wastewater technology Prentice-Hall.
8. Kerr C (1990) Community health and sanitation Intermediate Technology Publications. 9. Loewenthal RE, Wiechers HNS and Marais GvR (1986) 1986. Softening and Stabilization of Municipal Watesr Water Research Commission, Pretoria
10. Van Duuren FA (1997) Water purification works design Water Research Commission. 11
11. Reference: Small Water System Operation and Maintenance, California State University, Ch. 1 Answer: A

AKNOWLEDGEMENT

We wish to extend thanks and appreciation to the many representatives of TVET Institutes, instructors and respective of agro food processing who donated their time and expertise to the development of this TTLM.

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

This TTLM was developed on October 2020 at Bishoftu management institutes.

The trainers who developed the learning guide

No	Name	Qualification	Educational background	Region	E-mail
1	BEREKET BALCHA	B	Chemical engineering in (processing stream)	SNNPR	Bereketbate@gmail.com
2	Deribow Gonfa	A	Plant science	Oromia	gonfad24@gmail.com
3	Marid Tadesse	A	Post-harvest management	Oromia	mtaddese19@gmail.com