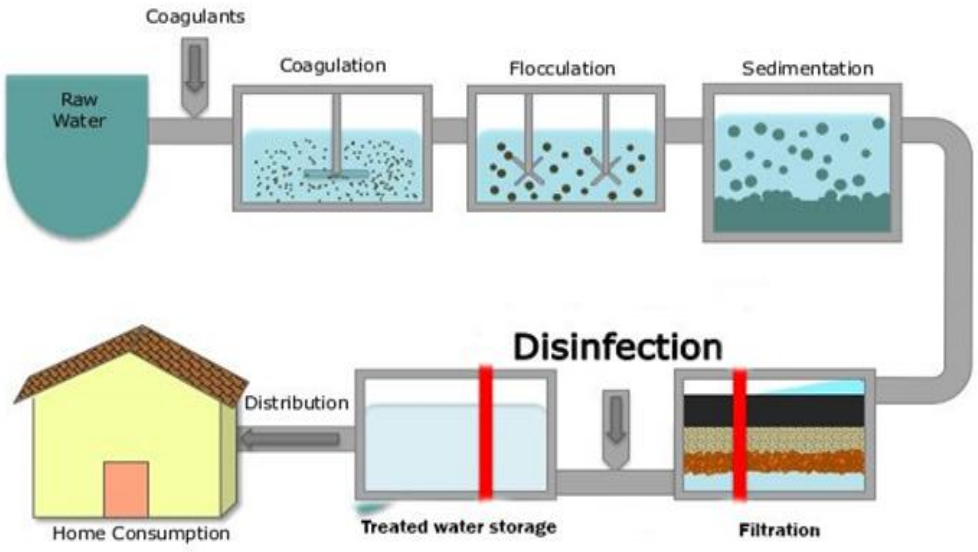
Fruit and Vegetable Processing
Level -II

Based on June 2021, Version-3 Occupational Standard (OS)



Module Title: - Operating Water Purification Process

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Introduction to the Module

This module covers the knowledge, skills and attitudes required to set up, operate, adjust and shut down a water treatment and purification process to produce water to meet production requirements. Further, it covers preparing the water purification equipment and process for operation, operating and monitoring the water treatment purification process, shutting down the water purification process, and recording workplace information.

LG #6	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:

- Introduction to the module
- Confirming available materials to meet operating requirements
- Identifying and confirming cleaning and sanitizing requirements
- Wearing and ensuring appropriate personal protective clothing correct fit
- Confirming available services for operation
- Completing batch records
- Entering Processing/operating parameters to meet safety and production requirements.
- Checking and adjusting equipment performance
- Carrying out Pre-start checks with workplace 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:

- 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
- Enter 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
4. Accomplish the Self-checks
5. Perform Operation Sheets

   Do the “LAP test”

Information Sheet -1

1.1. Confirming available materials to meet operating requirements

1.1.1. Introduction

Water purification is the process of removing unwanted chemical compounds, organic and inorganic materials, and biological contaminants from water. The process of water purification is essential to provide clean drinking water and supplies treated water for domestic, industrial, medical, and pharmacological uses. The water purification process involves several steps. The first step is coagulation, where chemicals are added to the water to cause small particles suspended in the water to clump together. The second step is sedimentation, where the water is allowed to sit undisturbed so that the heavier particles settle to the bottom. The third step is filtration, where the water is passed through a filter to remove any remaining particles. The fourth step is disinfection, where the water is treated with chemicals or ultraviolet light to kill any remaining bacteria or viruses.

- The specific materials required for a water purification process can vary depending on the purification method and the contaminants present in the water source. However, here are common materials and equipment used in water purification processes:-

✓ **Coagulants**: These are chemicals used to promote the clumping of fine particles in the water, making it easier to remove them. Common coagulants include aluminum sulfate (alum), ferric chloride, and polyaluminum chloride.

✓ **Flocculants**: These chemicals are added after coagulation to create larger particles called flocs, which can settle or be filtered more easily. Examples of flocculants include polyacrylamide and polyamine.

✓ **Filter media**: Depending on the purification method, various filter media can be used to remove suspended solids and other contaminants. Some common types include sand, activated carbon, diatomaceous earth, and anthracite coal.

✓ **Membranes**: In membrane filtration processes like reverse osmosis (RO) or nanofiltration, specialized membranes are used to separate contaminants from the water. These membranes are typically made of materials such as polyamide, cellulose acetate, or thin film composite.

- ✓ **Disinfectants**: To kill or inactivate harmful microorganisms, disinfectants are added to the water. Chlorine compounds (such as chlorine gas, sodium hypochlorite, or calcium hypochlorite), chloramines, ozone, or ultraviolet (UV) light are commonly used disinfection methods.
- ✓ **pH adjustment chemicals**: Depending on the water source and treatment process, pH adjustment may be necessary. Chemicals like lime (calcium hydroxide), soda ash (sodium carbonate), or sulfuric acid can be used to increase or decrease the pH as needed.
- ✓ **Pumps and pipes:** These are necessary for transporting water throughout the purification system. Pumps provide the necessary pressure to move water through the treatment process, while pipes and tubing distribute the treated water to its destination.
- ✓ **Monitoring and control instruments**: Sensors, meters, and instruments are used to monitor and control various parameters during the purification process, such as pH, turbidity, chlorine levels, flow rates, and pressure.
- ✓ **UV (Ultraviolet) Disinfection Unit**: Utilizes UV light to kill or inactivate microorganisms such as bacteria, viruses, and parasites.
- ✓ **Dosing equipment**: Dosing equipment is used to accurately add chemicals, such as coagulants, flocculants, or disinfectants, to the water in controlled amounts.
- ✓ **Storage tanks**: Storage tanks are used to hold and store water before or after treatment. They can vary in size and material depending on the volume of water to be stored.
- ✓ **Pumps**: Pumps are used to move water through the purification system by creating the necessary pressure or flow rates. They are essential for the proper functioning of filtration, disinfection, and other processes.
- ✓ **Valves**: Valves are used to control the flow of water and regulate the operation of different parts of the purification system. They are crucial for diverting, directing, or stopping the water flow as needed.
- ✓ **Distillation systems:** Distillation systems use heat to evaporate water and then condense the vapor to produce purified water. These systems are effective in removing most contaminants, including minerals, heavy metals, and microorganisms.
- ✓ **Reverse osmosis systems**: Reverse osmosis (RO) systems use a semi-permeable membrane to remove dissolved salts, minerals, and other contaminants from water. They are commonly used for desalination and producing high-quality drinking water.

- ✓ **Ultrafilter and microfilter**: Ultrafiltration (UF) and microfiltration (MF) systems use membranes with specific pore sizes to remove suspended solids, bacteria, and some viruses from water. They are often used as pre-treatment steps for other purification processes or as standalone filtration methods.
- ✓ **UV light**: Ultraviolet (UV) light systems utilize UV lamps to disinfect water by damaging the DNA of microorganisms, rendering them unable to reproduce. UV disinfection is effective against bacteria, viruses, and parasites.
- ✓ **Ozone generator**: Ozone generators produce ozone gas, a powerful oxidizing agent that can effectively kill microorganisms and remove odors and organic compounds from water.
- ✓ **Deionization plants**: Deionization plants use ion exchange resins to remove dissolved ions, such as minerals and salts, from water. They are commonly used for producing high-purity water for specific applications.
- ✓ **Softeners**: Water softeners use ion exchange processes to remove hardness minerals, such as calcium and magnesium ions, from water. They help prevent scale buildup in pipes and appliances.
- ✓ **Carbon tanks**: Carbon tanks contain activated carbon media for the removal of organic compounds, chlorine, and other chemical contaminants through adsorption.
- ✓ **Sand filter**: Sand filters use layers of sand to remove suspended solids and sediment from water. They are commonly used as a primary filtration step or as part of a multi-stage filtration system.
- ✓ **Filters:** Filters encompass various types, including multimedia filters, cartridge filters, or bag filters. They are used to remove different-sized particles and contaminants from water.
- ✓ **Polisher**: A polisher is a final treatment step that further improves the quality of treated water by removing any residual impurities or fine particles



Figure: 1.1. Water storage tank

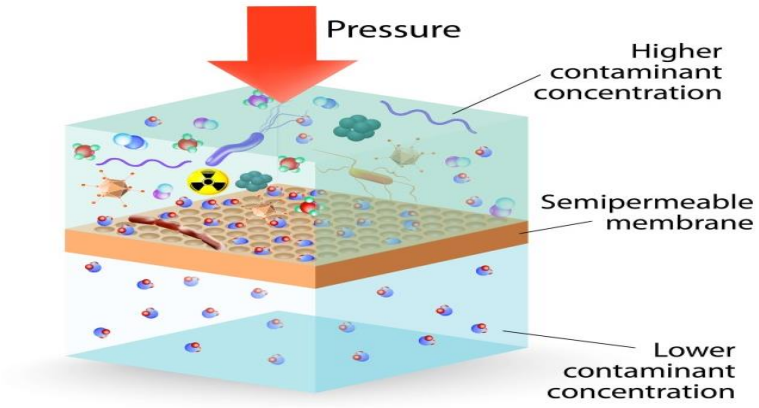


Figure: 1.2. Reverse osmosis systems

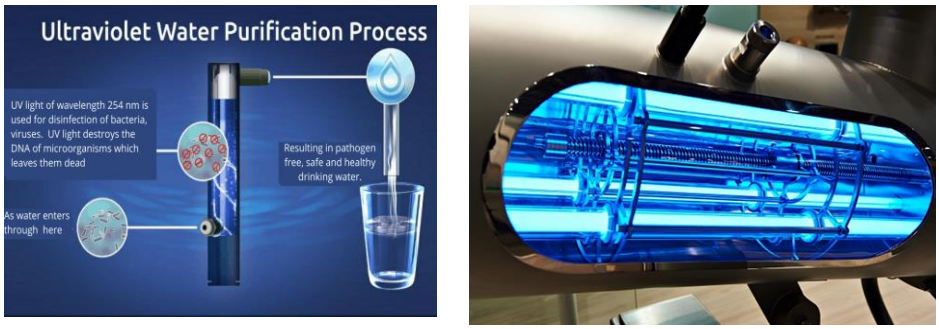


Figure: 1.3. UV devices for water purification process

1.2. Identifying and Confirming cleaning and sanitizing requirements

Cleaning and sanitizing are important steps in water industry purification operations. Raw water tanks and purified water tanks should be cleaned and sanitized regularly to ensure that the water is free from contamination. The frequency of cleaning of raw water storage tank should be every 15 days. The final wash water is collected and the pH of the sample must range between 7.0 ± 2.0 2. It's mandatory that the water meet the specifications as per Quality Control.

Cleaning is a process which will remove soil and prevent accumulation of food residues which may decompose or support the growth of disease causing organisms or the production of toxins.

- Listed below are the five basic types of cleaning compounds and their major functions:

✓ Basic Alkalis - Soften the water (by precipitation of the hardness ions), and saponify fats (the chemical reaction between an alkali and a fat in which soap is produced).

✓ Complex Phosphates - Emulsify fats and oils, disperse and suspend oils, peptize proteins, soften water by sequestering, and provide risibility characteristics without being corrosive.

✓ Surfactant - (Wetting Agents) Emulsify fats, disperse fats, provide wetting properties, form suds, and provide risibility characteristics without being corrosive.

✓ Chelating - (Organic compounds) Soften the water by sequestering, prevent mineral deposits, and peptize proteins without being corrosive.

✓ Acids - Good at mineral deposit control; and soften the water. Cleaning is the complete removal of food soil 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.

- When considering a good cleaner the following properties should be considered:
  - ✓ Quick and complete solubility.
  - ✓ Good wetting or penetrating action.
  - ✓ Dissolving action of food solids.
  - ✓ Emulsifying action on fat.
  - ✓ Deflocculating, dispersing, or suspending action.
  - ✓ Good rinsing properties.
  - ✓ Complete water softening power.

- ✓ Noncorrosive on metal surfaces.
- ✓ Germicidal action.
- ✓ Economical to us

- The factors that affect cleaning efficiency are:
  - ✓ Selecting the right cleaner for the job.
  - ✓ Increasing the temperature of the cleaning solution so that the strength of the bond between the soil and surface is decreased, the viscosity is decreased, and the solubility of the soluble materials and the chemical reaction rate is increased.
  - ✓ Increasing the turbulence "elbow grease".
  - ✓ Increasing the time the cleaner has contact with the surface needing cleaned.
  - ✓ Increasing the concentration. Concentration is the least effective variable to change in cleaning.

It is important that the clean, sanitized equipment and surfaces drain dry and are stored dry so as to prevent bacteria growth. Necessary equipment (brushes, etc.) must also be clean and stored in a clean, sanitary manner

- **The cleaning operation**:

✓ Prewash - the removal of gross food particles before applying the cleaning solution. This may be accomplished by flushing the equipment surface with cold or warm water under moderate pressure. Very hot water or steam should not be used because it may make cleaning more difficult.

✓ Washing - the application of the cleaning compound. There are many methods of subjecting the surface of equipment to cleaning compounds and solutions.

Effectiveness and the economy of the method generally dictate its use.

A. Soaking - immersion in a cleaning solution.

B. Spray method - spraying cleaning solution on the surface. This method uses a fixed or portable spraying unit with either hot water or steam.

C. Clean-in-place systems (C.I.P.) - is an automated cleaning system generally used in conjunction with permanent-welded pipeline systems.

Fluid turbulence in the pipeline is considered to be the major source of energy required for soil removal.

D. Foaming - utilizes a concentrated blend of surfactant developed to be added to highly concentrated solution of either alkaline or acid cleaners. It produces stable, copious foam when applied with a foam generator.

E. Jelling - utilizes a concentrated powdered. jelling agent which is dissolved in hot water to form a viscous gel.

f. Abrasive cleaning - abrasive type powders and pastes are used for removing difficult soil.

3. Rinsing - the removal of all traces of the cleaning solution with clean potable water.

4. Sanitization - a process either by using heat or a chemical concentration that will reduce the bacterial count, including pathogens to a safe level on utensils and equipment after cleaning.

Sanitization

It is important to differentiate and define certain terminology:

- **Sterilize** refers to the statistical destruction and removal of all living organisms.
- **Disinfect** refers to inanimate objects and the destruction of all vegetative cells (not spores).
- **Sanitize** refers to the reduction of microorganisms to levels considered safe from a public
- Health viewpoint.

You can watch how to clean and sanitize the water tank by opening the video link below:-

Water Tank Cleaning By EPSCO L.L.C - GenYT.net

1.3. Wearing and ensuring personal protective cloth

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

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 treatment work:-

- muff,
- ear protection,
- eye and face protection,
- glove
- eye goggle
- Safety shoes
- Apron
- Protective wear.
- Hair net (head cup)



Figure: 1.4: personal protective equipment

- 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

1.4. Confirming available services for operation

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 treatment plant where they form part of the remaining sludge. All filter systems (sand filter, carbon filter, polishing filter and reverse osmosis membrane filters) need to be recovered, mostly through backwashing with clean water.

In addition to the general services mentioned earlier, there are specific services related to power, water, compressed air, and inert gas that are relevant to water purification operations. Here's an overview of these services:

- **Power Services:**

- ✓ Power Generation: Some service providers specialize in power generation solutions for water treatment facilities. They offer the design, installation, and maintenance of power generation systems such as diesel generators, gas turbines, or solar power systems. These systems provide a reliable source of electricity to support water purification operations.
- ✓ Power Management and Optimization: Service providers can assist in optimizing power consumption and improving energy efficiency within water treatment plants. They

analyze power usage, identify areas for improvement, and propose strategies to reduce energy consumption and operating costs.

- **Water Services:**

✓ Water Resource Management: Water purification service providers may offer services related to water resource management to ensure a sustainable and reliable water supply. This includes assessing water availability, developing water management plans, and implementing strategies for water conservation and reuse.

✓ Water Source Development: Some service providers can assist in identifying and developing new water sources for purification operations. This may involve conducting hydrogeological studies, drilling wells, implementing water extraction systems, and establishing water treatment infrastructure.

- **Compressed Air Services:**

✓ Compressed Air System Design and Installation: Service providers specializing in compressed air can design and install compressed air systems tailored to the needs of water treatment facilities. They consider factors such as air quality requirements, system capacity, and energy efficiency.

✓ Compressed Air Audits: Audits of compressed air systems can be conducted to assess their performance, identify potential energy inefficiencies, and recommend improvements. This helps optimize the use of compressed air and reduce energy costs.

- **Inert Gas Services:**

✓ Inert Gas Supply and Distribution: Providers can offer the supply and distribution of inert gases, such as nitrogen or carbon dioxide, required for specific water treatment processes. They ensure a reliable and continuous supply of inert gases to support the purification operations.

✓ Inert Gas System Design and Installation: Service providers can design and install inert gas systems, including storage tanks, pipelines, and control systems, to meet the specific needs of water treatment facilities. They ensure the safe and efficient utilization of inert gases.

1.5. Completing batch records documentation

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

- A list of the most common types of documents, along with a brief description of each:-

- ✓ 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.
- ✓ 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.
- ✓ Standard operating procedures (SOPs): Step-by-step instructions for performing operational tasks or activities.
- ✓ 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.
- ✓ 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.
- ✓ 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.
- ✓ 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.

- **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.

1.6. Entering Processing/operating parameters to meet safety and production requirements.

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 odor and to disinfect the water to complete demineralization of the water.

- 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 solution or 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).

1.7. Checking and adjusting equipment performance

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

a) **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.

b) **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:
  - ✓ Gather the tools to clean in the designed area for cleaning.
  - ✓ Segregate the tools according to the kinds of dirty they have.
  - ✓ Submerge the tools in the washing pan.
  - ✓ Use paint brush to remove the dirty from the tools.
  - ✓ Get the tools from the washing pan and wipe them with rags until dart.
  - ✓ Clean and keep all materials used for cleaning

1.8. Carrying out pre-start checks with workplace requirements

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:-

- 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





Figure: 1.6. Carrying out pre-start checks of water purification operations

Self-check -1	Written test

Name_____ ID_____ Date_____

Directions: Answer all the questions listed below

Test I: Choose the correct answer from the given alternatives

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. 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’)

5. Available Services for water purification are,

A. Power

B. water

C. compressed air

D. inert gas

6. 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

Test II: Short Answer Questions.

1. Write down water treatment equipment
2. List out pre start check procedures for water purification plant.
3. What it means pre start check?

Operation Sheet -1

1.1. Techniques/Procedures/Methods of carrying out pre-start checks before starting water purification operation

A. Tools and equipment

I. PPE
II. Checklist(logbooks)
III. Water quality testing equipment (pH meter, Turbidity meter)
IV. Flow meter
V. Pressure gauge

B. Procedures/Steps/Techniques

- Wear PPE.
- Review Standard Operating Procedures (SOPs).
  - ✓ Ensure that you have the latest versions and understand the procedures.
- Check Documentation
  - ✓ Verify that all required documentation, including permits, licenses, and safety data sheets (SDS), is up-to-date and readily available.
- Inspect Equipment
  - ✓ Perform a visual inspection of all water purification equipment.
  - ✓ Check for any signs of damage, leaks, or corrosion.
  - ✓ Ensure that valves, gauges, pumps, and other components are in good working condition.
  - ✓ Verify that equipment is properly labeled with necessary information.
- Verify Calibration
  - ✓ Check the calibration of instruments and sensors used in the water purification process. Calibrate if necessary.
  - ✓ Ensure that monitoring and control devices are accurate and reliable.
- Water Quality Analysis:
  - ✓ Conduct pre-start water quality tests to ensure that the water meets the required standards.

- Chemical Inventory
  - ✓ Ensure that chemicals are stored properly, and their quantities are sufficient for the upcoming operations.
- Safety Checks
  - ✓ Inspect safety features, such as emergency shut-off systems, eyewash stations, and fire extinguishers.
- Record Keeping:
  - ✓ Establish a system for documenting pre-start checks, including any identified issues and corrective actions taken.
- Workplace Cleanliness:
  - ✓ Ensure that the workplace is clean and free from debris.
  - ✓ Verify that waste disposal procedures are in place and followed.
- Regulatory Compliance
  - ✓ Confirm compliance with all relevant regulatory requirements governing water purification operations.

LAP Test -1	**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 Perform pre-start checks of water purification operations

LG #7	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
- Identifying, rectifying and reporting out-of-specification process
- Maintaining the work area to housekeeping standards.

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
- identify out-of-specification process outcomes
- Maintain work area housekeeping standards.

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet -2

2.1. Starting and operating process

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.

2.1.1. 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

I. **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.

II. **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.

III. **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.

IV. **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.

2.1.2. 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: oxidases taste- and odor-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). Multimedia 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

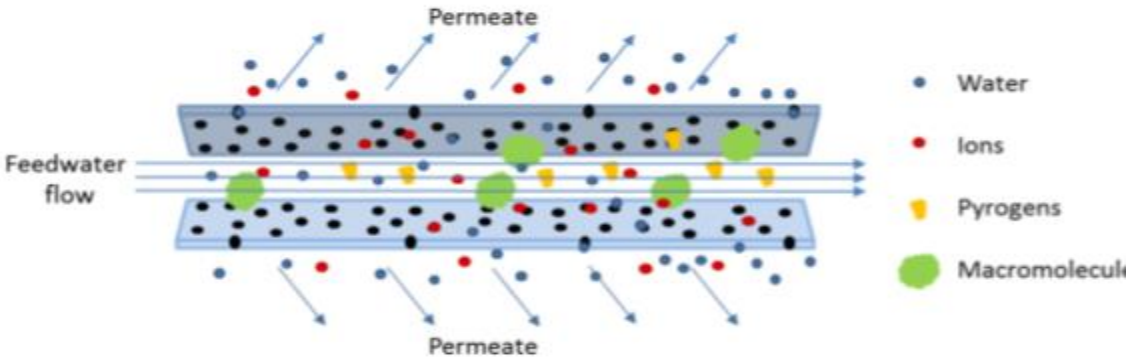


Figure: 2.1. Water purification by reverse osmosis process

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

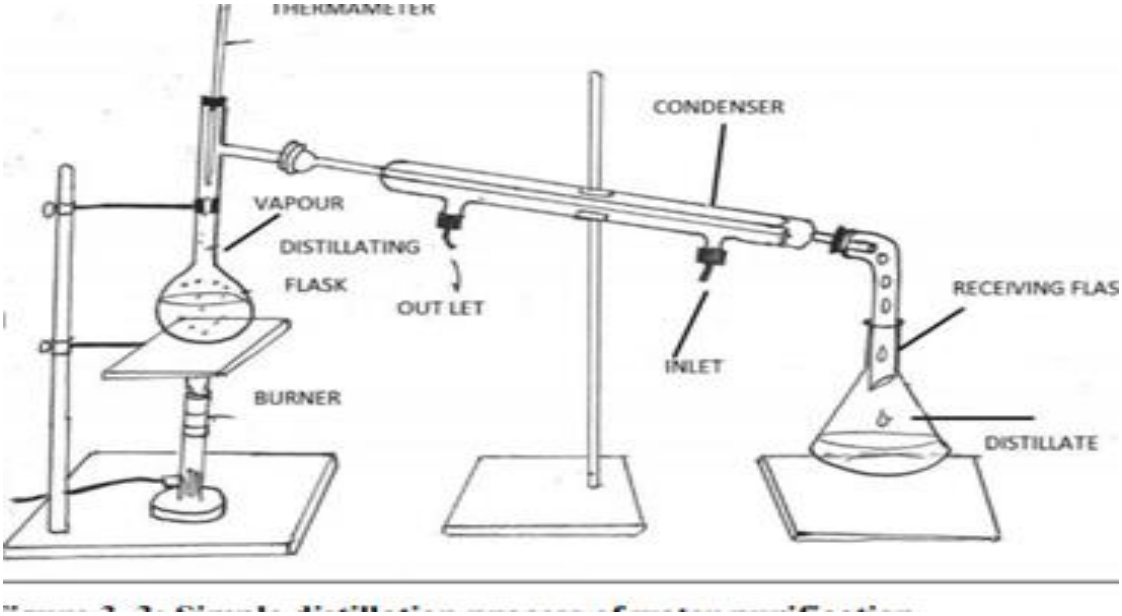


Figure: 2. 2 Water purification by distillation process

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 0.2 µm 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.

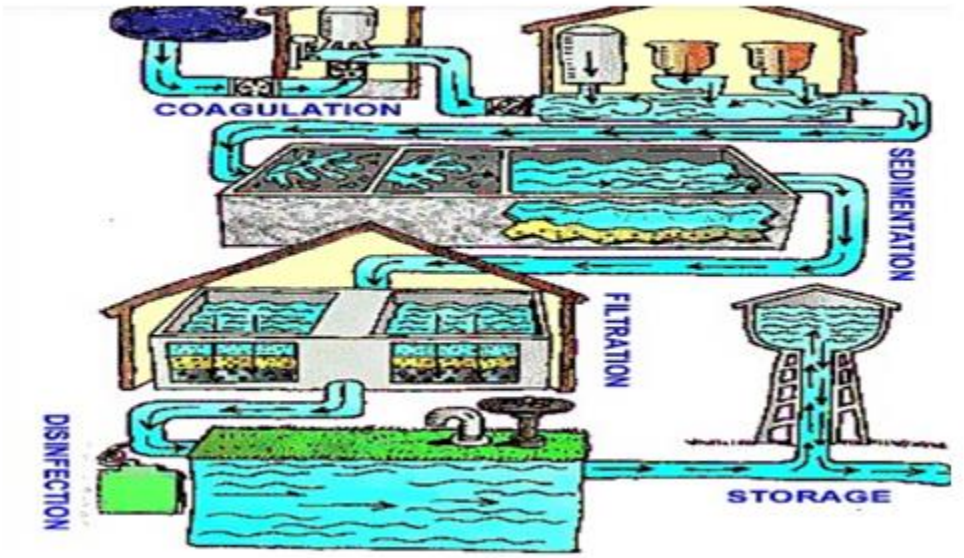


Figure: 2.3 Overall water purification process in industry.

Purification start-up procedures

Start-up procedures help ensures 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.

Facilities

- **Review your water 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.

- **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.

- **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:**

- ✓ **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.

- **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.

- **Water produced are includes the following types:-**
  - ✓ purified water
  - ✓ deionized water
  - ✓ reverse osmosis (RO)water
  - ✓ distilled water
  - ✓ water for injection (WFI)
  - ✓ treated water
  - ✓ mineral water

Watch the water treatment process video by opening the links below:-

The water treatment process - GenYT.net

2.2. Monitoring equipment

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

2.3. Identifying variation in equipment operation

2.3.1. 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.

2.3. 2. Reporting maintenance requirements

Point-of-use water treatment equipment in general is not fit and forgets 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

2.3.3. 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.

2.4. Monitoring process to confirm purified and treated water

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.

- **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

2.5. Identifying, rectifying and reporting out-of-specification process

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.

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.

2.6. Maintaining the work area to housekeeping standards

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 management and results. This is generally carried out by a cleaning unit which contains the required cleani ng solutions and controls the cleaning sequences

Self-Check – 2	Written test

Name: _____ID:_____ Date_____

Directions: Answer all the questions listed belowI.**Choose the correct answer from the given alternatives**

1. Commonly used types of filtration except one
   A. Micro porous filtration
   B. Ultrafiltration
   C. Activated carbon filters
   D. Aeration
2. Removes algae and plankton from the raw water.
   A. Deionization
   B. Aeration
   C. Photo-oxidation
   D. Micro strainer
3. What are the out-of-specification process outcomes?
   A. The pH
   B. Turbidity
   C. Alkalinity
   D. The hardness

II: Short Answer Questions

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

Operation Sheet -2

2.1. Techniques/Procedures/Methods of operating and monitoring water purification process

E. Tools and equipment

I. PPE

II. Pumps

III. Valves

IV. Monitoring Instruments (pH meter, Turbidity meter, Conductivity meter, TDS meter, Flow meter, Pressure gauge)

V. Tanks and Reservoirs

VI. Filters

VII. Membrane Systems

VIII. Online Sensors

IX. Emergency Response Equipment

X. Documentation and Record-Keeping Materials

B. Procedures/Steps/Techniques

- Wear personal protective equipment.
- Set up all necessary equipment for operation
  - ✓ Calibration
- **Enter and setup processing parameters**
  - ✓ Online Monitoring (pH, conductivity, turbidity, and total dissolved solids (TDS))
  - ✓ Chemical Analysis
  - ✓ Monitoring Flow Rate and Pressure
  - ✓ Microbiological Testing
- Start operating
- Check and confirm purified (treated) water
- Record Keeping

LAP Test -2	**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 Perform the water purification process

LG #8	**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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet -3

3.1. Identifying the appropriate shut down procedure

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

3.2. Shut down the process

- Requirements of shutting down the process 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

3.3. Readying equipment for CIP (cleaning in place)

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.

- **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 management and results. This is generally carried out by a cleaning unit which contains the required cleaning solu tions, and controls the cleaning sequences.

3.4. Completing workplace documentation

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.

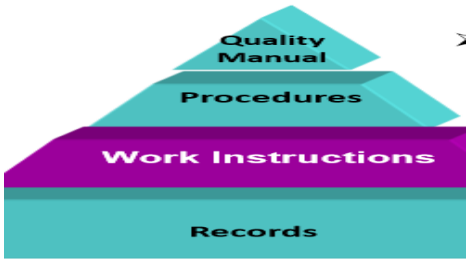
- Documents provide written information about policies, processes, and procedures.

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.

- **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



3.5. Identifying and reporting maintenance requirements

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 those are necessary to ensure satisfactory operation.

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: Choose the correct answer from the given alternatives

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. 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 clea
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

3. Documents shall be

A. be designed, prepared and laid out in an orderly fashion

B. has 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

4. 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

Operation Sheet – 3

3.2. Methods of shutting down water purification operation

A. Tools and equipment

I. Personal Protective Equipment (PPE)

II. Logbooks

III. Valve locks and Tags

IV. Pump shut down tools

V. Equipment for draining (pumps or siphons)

B. Procedures

- Wear personal protective equipment.
- Evaluate the water system
- Drain the storage tank
- Drain Pressure tanks, when not in use
- Shut down the source, Turn off the power to all treatment systems
- Shut down treatment discards, unused chlorine solutions and stock

✓ Turn off the power to all treatment systems.

- Document the shutdown process

LAP Test -3	**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 – Perform shutting down water purification operation

LG #9	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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet -4

4.1. Conducting work with workplace information and environmental guidelines

Conducting work with workplace information and environmental guidelines during water purification operations in industry involves adhering to established protocols to ensure the safety of personnel, protect the environment, and maintain the efficiency of the purification process.

Here are some steps and guidelines to consider:

4.1.1. Workplace information requirements and environmental guidelines

- **Understand workplace information:**

Review Documentation: Familiarize yourself with relevant documents, manuals, and standard operating procedures (SOPs) related to water purification in your industry.

Training: Ensure that all personnel involved in the water purification process are adequately trained and understand the procedures and safety measures.

- **Environmental guidelines:**

Compliance: Ensure that your water purification processes comply with local, regional, and national environmental regulations.

Permitting: Obtain any necessary permits for water usage, discharge, and waste handling, as required by environmental authorities.

- **Safety measures:**

Personal Protective Equipment (PPE): Provide and enforce the use of appropriate PPE, such as gloves, goggles, and respiratory protection, depending on the chemicals and processes involved.

Emergency Response Plan: Develop and communicate a comprehensive emergency response plan that includes procedures for spills, leaks, or other incidents.

- **Water quality standards:**

Monitor Water Quality: Implement a monitoring system to regularly check and maintain water quality standards throughout the purification process.

Testing Protocols: Follow established testing protocols for various contaminants and ensure that the water meets the required specifications.

- **Waste management:**

Treatment of Residuals: Establish procedures for the proper treatment and disposal of residual materials generated during the purification process.

Recycling Opportunities: Explore opportunities for recycling or reusing certain by-products to minimize environmental impact.

- **Equipment maintenance:**

Regular Inspections: Conduct regular inspections of purification equipment to identify and address any potential issues promptly.

Calibration: Calibrate monitoring and testing equipment regularly to ensure accurate readings.

- **Communication and reporting:**

Communication Channels: Establish clear communication channels for reporting any issues or concerns related to the water purification process.

Record Keeping: Maintain thorough records of water quality data, equipment maintenance, and any incidents for future reference and regulatory compliance.

- **Continuous improvement:**

Periodic Reviews: Periodically review and update procedures based on lessons learned, technological advancements, and changes in regulations.

Employee Feedback: Encourage feedback from employees involved in the water purification process to identify areas for improvement.

- **Community engagement:**

Community Relations: Maintain open communication with local communities, addressing any concerns they may have about the environmental impact of water purification operations.

4.1.2. Following national and international guidelines

- **The food standards code, including labeling, weights and measures legislation:**

Food Standards Code: This refers to a comprehensive set of regulations governing the safety and quality of food products. In the context of water purification, adherence to specific standards ensures that water used in food and beverage production meets quality and safety criteria.

Labeling Requirements: These regulations dictate how water products are labeled. It includes details such as source identification, treatment methods, and any additives used in the water purification process.

Weights and Measures Legislation: Pertains to ensuring accuracy in the measurement and packaging of water products. This is crucial for consumer protection, preventing misrepresentation of the quantity of water in a package.

- **Legislation covering food safety, environmental management, ohs, anti-discrimination, and equal opportunity:**

Food Safety Legislation: Focuses on measures to ensure that water used in the food and beverage industry is safe for consumption. It includes guidelines for water treatment, storage, and transport to prevent contamination.

Environmental Management Regulations: Address the environmental impact of water purification operations. This involves compliance with standards for wastewater discharge, energy consumption, and sustainable water sourcing.

Occupational Health and Safety (OHS): Pertains to the safety of workers involved in water purification processes. It includes guidelines for the safe handling of equipment, chemicals, and potential hazards.

Anti-discrimination and Equal Opportunity Laws: Ensure that all individuals, irrespective of background, have equal opportunities in employment within water purification operations.

- **Relevant GMP codes in the beverage industry:**

Good Manufacturing Practices (GMP): GMP codes are crucial in the beverage industry to ensure the quality and safety of products. In water purification, GMP would focus on maintaining the highest standards of hygiene, equipment maintenance, and quality control.

Replacement of Ethiopian Food Standards Code: In the beverage industry, GMP codes may replace or complement the Ethiopian Food Standards Code, particularly in areas related to manufacturing practices and product quality.

Emphasis on GMP for Water Safety: GMP guidelines in the beverage industry underscore the critical role of water quality in the production process. They often provide detailed instructions on water purification methods and monitoring.

- **WHO standards:**

World Health Organization (WHO) Standards: These are global benchmarks for water quality. In the context of water purification operations, WHO standards guide the industry in ensuring that water is safe for consumption and free from contaminants.

Emphasis on Health and Safety: WHO standards focus on health and safety, emphasizing the need for water purification processes that eliminate or reduce harmful substances to levels deemed safe for human consumption.

International Alignment: Adhering to WHO standards is important for international trade, as they provide a universally recognized set of criteria for water quality.

- 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.

4.2. Maintaining work place records

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

2.3. Recording workplace information in appropriate format

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
- **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.

1. **General Information:**

- **Batch Number:**
- **Date of Production:**
- **Shift/Time of Production:**
- **Operator/Supervisor:**
- **Equipment Used:**

2. **Raw Materials:**

- **List of Raw Materials:**
  - ☐ Material 1
  - ☐ Material 2
  - ☐ ...
- **Supplier Information:**
  - ☐ Supplier A
  - ☐ Supplier B
  - ☐ ...

3. **Equipment Setup:**

- **Equipment Cleaning and Sterilization:**
  - ☐ Cleaned
  - ☐ Sterilized
- **Calibration Checks:**
  - ☐ Equipment 1
  - ☐ Equipment 2
  - ☐ ...

4. **Process Steps:**

- **Step 1: [Description]**
  - ☐ Completed
  - ☐ Not Completed
  - ☐ Notes:
- **Step 2: [Description]**

- ☐ Completed
- ☐ Not Completed
- ☐ Notes:

- **...

5. **Quality Control:**

- **In-Process Testing:**
  - ☐ Test 1
  - ☐ Test 2
  - ☐ ...
- **Final Product Testing:**
  - ☐ Test A
  - ☐ Test B
  - ☐ ...

6. **Environmental Conditions:**

- **Temperature:**
- **Humidity:**
- **...

7. **Packaging:**

- **Packaging Materials Used:**
  - ☐ Packaging Material 1
  - ☐ Packaging Material 2
  - ☐ ...
- **Packaging Line Checks:**
  - ☐ Completed
  - ☐ Not Completed
  - ☐ Notes:

8. **Documentation and Records:**

- **Batch Record Review:**
  - ☐ Reviewed by [Name]

- ☐ Approved by [Name]
- ☐ Date: [Date]

- **Additional Notes or Comments:**

9. **Incidents and Deviations:**

- **Record any incidents, deviations, or unexpected events during the batch production process. Include corrective actions taken.**

10. **Final Approval:**

- **QA/QC Approval:**
  - ☐ Approved
  - ☐ Not Approved
  - ☐ Date: [Date]

11. **Storage and Distribution:**

- **Storage Conditions:**
- **Distribution Plan:**

12. **Batch Closure:**

- **Final Comments:**
- **Date and Time of Batch Closure:**

Figure: 4.1. Templates of Production batch records

2.4. 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.

2.5. Communicating record information

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.

- **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

4.6. Keeping workplace information record

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.

- **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 -4	Written Test

Name: _____ID:_____ Date: _____

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

I: Choose the best answer

1. All records should be
   A. Legible and clear
   B. Dated
   C. Readily identifiable and retrievable
   D. Carry authorization status
   E. Protected from damage and deterioration while storage
   F. All
2. Batch records should include.
   A. COA records
   B. COA records
   C. Equipment log
   D. Labeling log
   E. Packaging log
   F. All
3. which one of the following is workplace information
   A. Standard Operating Procedures (SOPs)
   B. Manufacturers' advice
   C. Manufacturers' guidelines
   D. All

Operation Sheet -4

4.1. Techniques/Procedures/Methods of recording batch information

A. Tools and equipment

I. PPE
II. Checklists
III. Stationary materials

B. Procedures/Steps/Techniques

- Wear appropriate PPE.
- Batch Identification.
  - ✓ Assign a Unique Batch Number.
  - ✓ Record the Date and Time of Production.
- Raw Material Documentation.
  - ✓ List of Raw Materials Used.
- Equipment Setup and Calibration.
- Step-by-Step Process Documentation.
- Quality Control Documentation.
- Environmental Conditions Monitoring.
- Documentation and Record Review.
- Final Approval and Batch Closure.
  - ✓ Confirm that the batch meets all quality standards.

LAP Test -4	**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 Perform recording batch information

Reference materials

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