Drinking Water Operator Certification Training
Instructor Guide

Module 14:
Conventional Filtration

This course includes content developed by the Pennsylvania Department of Environmental Protection (Pa. DEP) in cooperation with the following contractors, subcontractors, or grantees:

The Pennsylvania State Association of Township Supervisors (PSATS)
Gannett Fleming, Inc.
Dering Consulting Group
Penn State Harrisburg Environmental Training Center

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A Note to the Instructor

Dear Instructor:

The primary purpose of *Module 14: Conventional Filtration* is to provide an introduction to the conventional filtration process commonly used to treat drinking water. This module has been designed to be completed in 6 hours, but the actual course length will depend upon content and/or delivery modifications and results of course dry runs performed by the DEP-approved sponsor. The number of contact hours of credit assigned to this course is based upon the contact hours approved under the DEP course approval process. To help you prepare a personal lesson plan, timeframes have been included in the instructor guide at the Unit level and at the Roman numeral level of the topical outline. You may need to adjust these timeframes as necessary to match course content and delivery modifications made by the sponsor. Please make sure that all teaching points are covered and that the course is delivered as approved by DEP.

Web site URLs and other references are subject to change, and it is the training sponsor's responsibility to keep such references up to date.

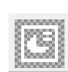
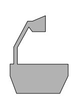
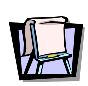
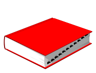
Delivery methods to be used for this course include:

- Lecture
- Exercise/Activity
- Calculations

To present this module, you will need the following materials:

- One workbook per participant
- Extra pencils
- Laptop (loaded with PowerPoint) and an LCD projector **or** overheads of presentation and an overhead projector
- Screen
- Flip Chart
- Markers

Icons to become familiar with include:

Participant Workbook		Instructor Guide	
	Exercise/Activity	Same icons for Participant Workbook apply to the Instructor Guide.	
	Case Study	**Ans:**	Answer to exercise, case study, discussion, question, etc.
	Discussion Question		PowerPoint Slide
	Calculation(s)		Overhead
	Exercise		Flip Chart
	Key Definition(s)		Suggested "Script"
	Key Point(s)		

Instructor text that is meant to be general instructions for the instructor is designated by being written in script font and enclosed in brackets. For example:

[*Ask participants if they have any questions on how to read the table. Answer any questions participants may have about how to read the table.]*

If your module includes the use of a PowerPoint presentation, below are some helpful controls that you may use within the Slide Show.

PowerPoint Slide Show Controls

You can use the following shortcuts while running your slide show in full-screen mode.

To	**Press**
Advance to the next slide	N, ENTER, or the SPACEBAR (or click the mouse)
Return to the previous slide	P or BACKSPACE
Go to slide <number>	<number>+ENTER
Display a black screen, or return to the slide show from a black screen	B
Display a white screen, or return to the slide show from a white screen	W
Stop or restart an automatic slide show	S
End a slide show	ESC
Return to the first slide	Both mouse buttons for 2 seconds
Change the pointer to a pen	CTRL+P
Change the pen to a pointer	CTRL+A
Hide the pointer and button temporarily	CTRL+H
Hide the pointer and button always	CTRL+L
Display the shortcut menu	SHIFT+F10 (or right-click)
Erase on-screen annotations	E
Go to next hidden slide	H
Set new timings while rehearsing	T
Use original timings while rehearsing	O
Use mouse-click to advance while rehearsing	M

INTRODUCTION OF MODULE: 5 minutes

Display Slide 1—Module 14: Conventional Filtration.

[Welcome participants to "Module 14—Conventional Filtration." Indicate the primary purpose of this course is to provide an introduction to the conventional filtration process commonly used to treat drinking water.]

[Introduce yourself.]

[Provide a brief overview of the module.]

This module contains 5 units. On page i, you will see the topical outline for **Unit 1—Conventional Water Treatment Overview**.

[Briefly review Unit 1 of the outline.]

If you turn the page, you will see the topical outline for **Unit 2—Mixing, Coagulation, and Flocculation**, and **Unit 3—Sedimentation/Clarification**.

[Briefly review Units 2 and 3 of the outline.]

If you turn the page, you will see the topical outline for **Unit 4—Filtration.**

[Briefly review Unit 4 of the outline.]

If you turn the page, you will see the topical outline for **Unit 5—Operation of Conventional Filtration Facilities**.

[Complete the outline review.]

UNIT 1: 20 minutes

Display Slide 2—Unit 1: Conventional Water Treatment Overview.

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

- Use vocabulary appropriate to conventional filtration of water in discussing the process.
- Follow the Typical Process Flow Diagram and identify the four major conventional filtration processes.

PURPOSE OF CONVENTIONAL WATER TREATMENT: 5 minutes

[Review the two purposes of conventional water treatment as presented in the participant workbook.]

Compliance with Regulations

[Review material on Compliance.]

Production of Safe Drinking Water

[Review material on Water Quality.]

There is a lot of terminology associated with water treatment. Let's turn the page.

TERMS AND DEFINITIONS: <u>10 minutes</u>

[As you review the definitions presented in the participant workbook, you may want to review in the order presented.]

[Note to the Instructor: The level of understanding of some of the terminology will be dependent upon the experience of the participants. You may need to rephrase some for participants or assure them that the concepts will become clearer as the module progresses and concrete examples are given.]

[Review Terms and Definitions.]

[Complete the review of Terms and Definitions.]

CONVENTIONAL WATER FILTRATION FLOW PROCESS: 2 minutes

Display Slide 3—Schematic of Typical Process Flow

[Review the presentation of the flow process as presented in the participant workbook. As you review each part of the process in the text, refer to the section of the schematic that applies.]

It is helpful to see the flow of the entire treatment process from the collection of raw water at the source through distribution of the treated water to the customers. Each of the components within the process is addressed in depth in the Modules indicated.

Although we are not going to talk about source water in this module, I want to note two important items about raw water collection. The first, bar screens or racks are important to prevent larger objects from entering the system which could cause damage to plant equipment. Second, inlets or gates should be located in a reservoir intake so that water can be taken form multiple depths.

Source Water
(Modules 2 and 3)

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Chemical Addition
(Module 21)

Pretreatment

The next two units in this module are dedicated to the components of pretreatment: mixing/coagulation, flocculation, and sedimentation. As indicated they are part of Pretreatment rather than filtration. However, what takes place during this pretreatment phase is critical to the filtration process and considered part of the Conventional Filtration Process.

Filtration

Filtration is the overall focus of this module and this step in the process is the sole focus of Unit 4.

[Continue to review the presentation of the flow process.]

Disinfection
(Modules 5, 24, 25, 26, and 27)

Corrosion Control
(Module 20)

Water Distribution
(Modules 8, 9 and 28)

UNIT 1 EXERCISE: 3 MINUTES

[Complete the crossword puzzle as a review of vocabulary.]

[You may want to have participants complete on their own at their convenience.]

Ans:

											[1]T						
											U						
											R						
											B						
											I						
											D			[2]C			
											I			O			
				[3]C	O	A	G	U	L	A	T	I	O	N			
											Y			V			
														E			
														N			[4]C
														T			L
										[5]D				I			A
	[6]F	L	O	C	C	U	L	A	T	I	O	N		O			R
										S				N			I
[7]S	E	D	I	M	E	N	T	A	T	I	O	N		A			F
										N				L			I
										F				[8]F	L	O	C
										E				I			A
										C				L			T
							[9]S			T				T			I
					[10]C	O	L	L	O	I	D	S		R			O
							U			O				A			N
							D			N				T			
							G							I			
							E							O			
														N			

[Review Unit 1 ***Key Points****.]*

[Ask participants if they have any questions on any of the material covered in Unit 1. Answer any question they may have.]

Now that we all have an idea of the "big" picture as to why we have conventional water treatment and the flow process involved; let's move on to Unit's 2 and 3 where we will focus on the pretreatment process.

UNIT 2: 30 minutes

Display Slide 4—Unit 2: Mixing, Coagulation, and Flocculation.

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

- List the major chemicals used in the coagulation process and explain their importance to the process.
- Explain the importance of flocculation to conventional filtration.
- List two types of mechanical flocculators in common use.

MIXING: 5 minutes

Display Slide 5—Mixing, Coagulation & Flocculation Schematic (Figure 2.1 of participant workbook).

[Review definition of Mixing as presented in workbook.]

[Point to the left side of the Schematic to illustrate introduction of chemicals, and to the rapid mixer for dispersal.]

Mixing Methods

Hydraulic Mixing

Display Slide 6—Hydraulic Mixer (Figure 2.2 of participant workbook).

In Figure 2.2 – you can see the components of a hydraulic mixer. As mentioned in the workbook, these are propelled by the movement of the water.

Mechanical Mixing

Display Slide 7—Propeller (Figure 2.3 of participant workbook).

In figure 2.3 – you can see the propeller used to mix the water. This is not unlike a propeller on a boat engine.

COAGULATION: <u>10 minutes</u>

Remember the definition of **coagulation** in Unit 1**?** Essentially, coagulation is the addition of chemicals (coagulants) to the water. Iinitially it causes the smaller non-settleable particles and colloidal suspensions to become destabilized and begin to clump together to form floc. We will begin our review of Coagulation with that of Coagulant Chemicals.

Coagulant Chemicals

The first chemicals we will look at are those that serve two basic functions: destabilization and clumping.

Primary Coagulants

[Review material as presented in participant workbook.]

Once the particles have become destabilized and start clumping together, they may need to be strengthened and become denser. For this we turn to Coagulant Aids.

Coagulant Aids

[Review material as presented in participant workbook.]

Some other chemicals that can be added to the water to add density to the flocs are Inorganic Chemicals.

Inorganic Chemicals

[Review material as presented in participant workbook.

You may want to note that the use of lime will also buffer pH and alkalinity depression normally found when using aluminum salts as the primary coagulant.]

The physical and chemical reaction that occurs between the alkalinity of the water and the coagulant results in the formation of insoluble flocs.

Basic Coagulant Chemistry

Dissolved Organic Matter

[Review material as presented.]

DOM is a diverse mixture of organic compounds found in the source water supply. These can range form dead and living organisms to partially–to-extensively degraded vegetative matter such as leaves. Historically organic matter in natural waters has been divided into dissolved and particulate organic carbon on the basis of filtration through a 0.45 micron filter. Generally the dissolved portion accounts for approximately 90 % of the total organic carbon found in most waters.

Organic matter derived from different source materials has distinctive chemical characteristics associated with those source materials. Organic matter derived from higher plants, for instance, has been found to have relatively large amounts of aromatic carbon, and is low in nitrogen content. Microbially-derived organic matter (from algae and bacteria), on the other hand, has greater nitrogen content, and low aromatic-C and phenolic content.

pH Dependent

[Review material as presented.]

Process Control

Chemical Reactions and the Formation of Floc are complex. Measuring and controlling performance of the plant is a daily responsibility, maybe more depending on the variability of the source water. The determination of type and dosage of coagulant chemicals is commonly made in the laboratory using a Jar Test.

Jar Testing should be done at least daily, whenever there is a change in the type of coagulant chemical used, and when the quality of raw water changes. Changes in raw water quality can be due to changes of raw water sources, and to physical events such as season of the year, recent rainfall events, and development or other changes on the watershed.

[Review key point.]

Calculate the dose, if 1500 pounds of dry Alum are required to treat 15-mgd of water.

So let's walk through this calculation: We know the formula is:
Loading (lbs/day) = Concentration(mg/L) * Flow (MGD) * 8.34 lbs/gal
We need to solve for:
? Concentration (mg/L) = 1,500 lbs./(15-mgd * 8.34 lbs/gal)
? Concentration (mg/L) = 12 mg/L

Chemical Safety

[Review material as presented.]

FLOCCULATION: <u>10 minutes</u>

As we learned in Unit 1, flocculation is a slow stirring process that causes the gathering together of small, coagulated particles into larger, settleable particles known as floc. In this section, we will learn how floc is formed and some performance considerations.

Floc Formation

The purpose of flocculation is to create floc of a good size, density, and toughness for later removal. Contact between particles promotes the gathering together of small coagulated particles forming larger ones. Particle contact is enhanced by the slow stirring process associated with flocculation

[Review material as presented.]

Performance Considerations

Coagulation and flocculation are the most important factors to the treatment plant performance. What happens during these processes affects the rest of the water treatment. This is not unlike a game of dominoes.

Stirring

[Review material presented in workbook.]

Detention Time

[Review material presented in workbook.]

If the performance of flocculation is poor, it will have an impact on disinfection. Let's turn the page to see what effects it has on disinfection.

[Review key point.]

Disinfection

[Review material presented in workbook.]

Now that we understand what flocculation is, how floc is formed and some performance considerations, let's look at the equipment used.

Types of Flocculators

Some flocculation is provided by turbulent flow associated with channel roughness, weirs, baffles, and orifices. However, it is the mechanical flocculator that the plant operator can control.

Display Slide 8—Horizontal Paddle Wheel Flocculator (Figure 2.4 of participant workbook).

[Point to the Paddle Wheel and note how it is horizontal.]

Display Slide 9—Vertical Flocculator (Figure 2.5 of participant workbook).

[Point out how the paddle or propeller is positioned.]

Vertical types may require less maintenance because it is easier to access the working parts for maintenance, and submerged bearings and packings are eliminated.

Another type of mechanical flocculator in use today, but not as common as the vertical and paddle wheel types is the “Walking Beam” Flocculator.

Display Slide 10—Walking Beam (Figure 2.6 of participant workbook).

[Review material on Walking Beam flocculators as presented.]

The place where the flocculators work is called the flocculation basin. These basins come in different sizes and shapes.

Flocculation Basins

Size and Shape

[Review material in workbook.]

Compartments

[Review material is workbook.]

Short circuiting is when water has a shortened flow path and thus reduces the detention time within the sedimentation process.

[Ask participants if they have any questions on flocculation or any of the material covered thus far. Answer as needed.]

[Review key point.]

UNIT 2 EXERCISE: 5 minutes

1. List the primary coagulants (3 metallic salts and 1 synthetic inorganic polymer) used in the coagulation process.

Ans: ***Aluminum Sulfate***
Ferric Sulfate
Ferric Chloride
Polyaluminum Chloride

2. In the space provided, explain the importance of coagulant aids—synthetic organic polymers.

Ans: ***Coagulant Aids strengthen and add density to the flocs.***

3. List two types of mechanical flocculators in common use.

Ans: Horizontal paddle wheel flocculator, and vertical flocculator.

For the following statements, make those that are true with a T, those that are false with an F.

4. ***T***_____ The effectiveness of sedimentation, filtration and overall plant performance depends on successful coagulation/flocculation.

5. ***F***_____ Poor coagulation/flocculation does not affect performance.

6. ***T***_____ Alum will decrease pH, adding lime to the flash mixer will increase lost alkalinity.

7. ***F***_____ When dissolved in water, alum generally produces negatively charged ions.

8. ***F***_____ Using iron slats instead of alum for coagulation is less effective over a broader pH range.

9. ***T***_____ Adding chemicals at the wrong location may cause floc to be too large.

10. ***T***_____ Coagulants added in the influent line before a flash mix basin will produce better results.

11. ***T***_____ Mixing is the rapid uniform distribution of a chemical in the water being treated.

12. ***F***_____ Colloidal particles refer to the ions that settle out easily through gravity.

13. ***T***_____ If an operator observes floc splitting and breaking up in the flocculation chamber, the rate of the flocculators should be slowed down.

14. ***T***_____ The main purpose of coagulation/sedimentation is to remove turbidity.

[Review Unit 2 ***Key Points****.]*

The influent water has been mixed, treated with coagulant chemicals and flocculated. The next step in the process of water treatment is sedimentation. Remember, earlier I mentioned that the success of the sedimentation process is dependent upon the pre-treatment processes we just reviewed. Before we move on, are there any questions on mixing, coagulation or flocculation?

[Answer questions as needed. Then move on to Unit 3.]

[Continue to first page of Unit 3. Workbook page contains References]

UNIT 3: <u>65 minutes</u>

Display Slide 11—Unit 3: Sedimentation/Clarification.

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

- List five operating parameters important to sedimentation.
- Identify the four zones of a sedimentation basin.
- Given the formula and required data, calculate each of the following: detention time, surface loading rate, mean flow velocity, and weir loading rate.

Display Slide 12—Unit 3: Sedimentation/Clarification.

- Explain why tube or plate settlers increase settling efficiency.
- Identify five characteristics upon which the sedimentation process is dependent.

PRINCIPLES OF OPERATION: 15 minutes

In Unit 1, we learned that sedimentation is the removal of suspended solids (particles) that are denser (heavier) than water to reduce the load on the filters. In Unit 2 we learned about mixing, coagulation and flocculation – all processes leading up to sedimentation.

The sedimentation process is dependent upon the settling characteristics of the particulates in water.

Settling Characteristics

A particle's size, weight and shape all affect its ability to settle and sometimes are interdependent, as in gravitational settling.

Particle Size

[Review the material in workbook.]

Gravitation Settling

The size and density of the sand and silt affects its ability to settle. These, combined, affect the gravitation settling.

[Review the material in workbook.]

Particle Shape

[Review the material in workbook.]

Relationship of Downward Movement of Particle to Forward Flow Velocity

[Review the material in workbook.]

*[Review key point **Short Circuiting** as presented in workbook.]*

Water Temperature

[Review the material in workbook.

- *4 °C—With regards to maximum density and water expansion/contraction, you may want to use the example of ice forming at the bottom of the lake if this were not true, as opposed to forming on the top.]*

Electrical Charge on Particles

[Review the material in workbook.]

Environmental Conditions

[Review the material in workbook.]

As you can see, it's the currents that can cause the problem, and these are formed by different environmental conditions.

Now that we have an understanding of the settling characteristics – those things upon which successful sedimentation is dependent, we'll take a look at where the sedimentation takes place—in Sedimentation Basins.

Sedimentation Basin Characteristics

Basin Zones

Display Slide 13—Sedimentation Basin Zones.

[Point to the Inlet Zone on the slide. Review the material on Inlet Zone as presented in the workbook.]

The inlet zone should provide a smooth transition from the flocculation basin effluent, and it should distribute flow evenly over the entire cross-section of the settling zone.

The inlet zone design should minimize flow velocity near the sludge zone. High velocities could scour or re-suspend the settled sludge.

[Point to the Settling Zone on the slide. Review the material on Settling Zone as presented in the workbook.]

[Point to the Sludge Zone on the slide. Review the material on Sludge Zone as presented in the workbook.]

The sludge zone provides for temporary storage of the sludge and allows for its compaction.

Sludge is generally removed by scraper or vacuum devices which move along the bottom of the basin. Basins without mechanical sludge collection require periodic manual cleaning to remove the sludge. Once removed, the sludge is then transferred to other plant facilities for further handling.

[Point to the Outlet Zone on the slide. Review the material on Outlet Zone as presented in the workbook.]

Launders or adjustable weirs control the level and outflow velocity. Floc carries over to filters if velocity is too high.

All sedimentation basins have these four zones, but not all sedimentation basins are alike.

Basin Types

There are two basic types of basins, although there are three different shapes. Let's review the material to learn more.

[Review the material on Rectangular Basin as presented in workbook.]

The other shape is either circular or square. While these clarifiers are of two different shapes, they are essential the same type of basin based on the factors presented.

[Review the material on Circular or Square Basin as presented in workbook.]

The circular or square shaped clarifiers are more likely to have short-circuiting problems as there is a shorter physical distance from the inlet to the outlet because it uses depth to make up for the difference.

Although sedimentation basins or clarifiers come in different shapes, the operation of these different shaped units is essentially the same. As we discussed at the beginning of this unit, sedimentation is dependant on seven basic factors (settling characteristics). Let's now consider some of the Operating Parameters and calculations which are important to the successful operation of the sedimentation process.

Operating Parameters

The first operating parameter that we will consider is Detention Time.

Detention Time

[Review the key concept of Detention Time as presented in participant workbook.]

Theoretical Detention Time

Display Slide 14—Theoretical Detention Time Formula (Same as participant workbook).

[Review the formula as presented.]

Actual Detention Time

[Review the material as presented in participant workbook. Ask participants if they have any questions. Answer as needed.]

In addition to the time required for the water to move through the settling basin, a plant operator must consider the surface loading rate.

Surface Overflow Rate

[Review the key concept of Surface Overflow Rate as presented in participant workbook.]

Surface Overflow Rate is determined by dividing sedimentation basin flow rate (in gallons per minute or gallons per day) by basin surface area.

[Review the material as presented in participant workbook.]

Display Slide 15—Surface Loading Rate Equation (Same as participant workbook).

[Review the equation as presented.]

Another important parameter is Mean Flow Velocity. A very long, narrow, shallow basin may have the appropriate detention time and surface settling rate, but if the velocity through the basin is too fast, the material will be carried along in the flow stream and not settle effectively. Also, if the velocity is too fast, the settled sludge could be re-suspended.

Mean Flow Velocity

[Review the key concept of Mean Flow Velocity as presented in participant workbook..]

Mean Flow Velocity Is determined by dividing basin flow rate in gpm by the sedimentation basin cross-sectional area:

[Review the material as presented in workbook..]

Display Slide 16—Mean Flow Velocity Formula (Same as participant workbook).

[Review the equation as presented.]

Similarly, if the upward velocity of water as it enters the effluent weirs is too fast, floc will be carried out of the sedimentation basin. The Weir Loading Rate is the operating parameter which is monitored to determine this parameter.

Weir Loading Rate

[Review the key concept of Weir Loading Rate as presented in participant workbook.]

[Review the material as presented in workbook.]

Display Slide 17—Weir Loading Rate Formula (Same as participant workbook).

[Review the equation as presented.]

While, so far, we have been considering the conventional sedimentation process, several modifications to the conventional process have been developed which permit much higher hydraulic loading to be used in the same overall plan spatial area as conventional sedimentation. Generally, these processes rely on reducing the length of travel that a particle must fall in order to be captured in the sludge zone. Let's look at two common high rate modifications.

HIGH RATE SEDIMENTATION PROCESSES: 10 minutes

Tube or Plate Settlers

Physical Characteristics

[Review material as presented in participant workbook.]

Display Slide 18—Tube Settler Module (Figure 3.2 of participant workbook).

[Point out the tubes and their angles.]

Display Slide 19—Inclined Plate Settler (Figure 3.3 of participant workbook).

[Point out the plates, stacking, and inclined angle.]

Performance Characteristics

[Review the material in participant workbook.]

Settlers provide equivalent settling of a larger space in a small space, due to the increased effective area.

Uses

[Review the material in participant workbook.

Note that the installation of tube or plate settlers in a conventional sedimentation basin will provide additional capacity.]

In addition to tube or plate settlers which were developed to improve conventional gravitational settling, several other processes have been developed to improve the process performance. These modifications generally combine the processes of coagulation, flocculation and sedimentation into a single unit. Let's consider some of the more commonly used modifications.

Specialized Processes

Solids Contact Clarifiers

Display Slide 20—Solids Contact Clarifier (Figure 3.4 of participant workbook).

[Point out that the flocculated influent is passed through the existing sludge layer. This improves the contact between the floc and other collected solids assisting with the removal of the material.]

Ballasted Flocculation/Clarification

[Review material as presented in participant workbook.]

Display Slide 21—Actiflo Ballasted Flocculation/Clarification System (Figure 3.5 of participant workbook).

[Point out that sand and polymer are added as the floc is beginning to form in the coagulation process. This result is a much denser floc which is more easily removed.]

Upflow Contact Clarifier

[Review material as presented in participant workbook.]

Display Slide 22—Upflow Clarifier (Figure 3.6 of participant workbook).

[Point out that this is similar to an upflow filter in that the flow is passed through a media bed where the floc is captured. Note that the media is usually a courser material than that normally used in the filter.]

[Ask participants if they have any questions on the high rate sedimentation processes, or anything else covered thus far. Answer as needed.]

In the next section, we are going to look at some scenarios that you may run across in your plants. You will determine what calculations need to be done, and perform them. Let's turn the page and take a look.

SEDIMENTATION MATHEMATICAL CALCULATIONS: 30 minutes

Theoretical Detention Time

Theoretical Detention Time Calculation

[Ask participants to read the problem and complete. After about 5 minutes,]

Display Slide 23—Given Statement for Theoretical Detention Time.

[Read Given statement aloud.]

Display Slide 24—Problem Statement for Theoretical Detention Time.

[Read Problem statement aloud.]

The first thing we need to do is convert flow rate, which we note as Q, to gallons per hour.

Display Slide 25—Flow Rate, gallons per min.

$$\text{Q, gph} = \frac{\text{Q, MDG x 1,000,000}}{\text{24 hr/day}}$$

$$= \frac{\text{1.5 MGD x 1,000,000}}{\text{24 hr/day}}$$

$$= \text{62,500 gallons per hour}$$

Our second step is to calculate sedimentation basin volume in gallons.

Display Slide 26—Sedimentation Basin Volume.

Vol, gal = 2 basins x 20 ft wide x 60 ft long x 12 ft deep

= 28,000 cu ft x 7.48 gal/cu ft

= 215,424 gallons

Continued

The last step requires us to determine Detention Time (DT) in hours.

Display Slide 27—Detention Time.

$$DT_{(t)} = \frac{\text{Vol, gal}}{\text{Q, gph}}$$

$$= \frac{215{,}424 \text{ gal}}{62{,}500 \text{ gph}}$$

$$= 3.45 \text{ hours}$$

[Ask participants if they have any questions. Answer as needed.]

Surface Overflow Rate

Surface Overflow Rate Calculation

[Ask participants to read the problem and complete. After about 5 minutes,]

Display Slide 28—Given Statement for Surface Overflow Calculation.

[Read Given statement aloud.]

Display Slide 29—Problem Statement for Surface Overflow Calculation.

[Read Problem statement aloud.]

The first thing we need to do is convert flow rate, which we note as Q, to gallons per minute.

Display Slide 30—Flow Rate, gallons per min.

$$Q\text{,gpm} = \frac{\text{Q, MGD} \times 1{,}000{,}000}{24 \text{ hr/day} \times 60 \text{ min/hr}}$$

$$= \frac{1.5 \text{ mg} \times 1{,}000{,}000}{24 \text{ hr/day} \times 60 \text{ min/hr}}$$

$$= 1042 \text{ gpm}$$

Our next step is to determine the surface overflow rate in gallons per minute per square foot.

Display Slide 31—Surface Overflow Rate.

$$\text{Surface Loading} = \frac{\text{Q, gpm}}{\text{2 Basins x Basin Surface Area, sq ft}}$$

$$= \frac{1042 \text{ gpm}}{2 \text{ x}(20 \text{ ft x } 60 \text{ ft})}$$

$$= 0.43 \text{ gpm/sq ft}$$

[Ask participants if they have any questions. Answer as needed.]

Mean Flow Velocity

Mean Flow Velocity Calculation

[Ask participants to read the problem and complete. After about 5 minutes,]

Display Slide 32—Given Statement for Mean Flow Velocity Calculation.

[Read Given statement aloud.]

Display Slide 33—Problem Statement for Mean Flow Velocity Calculation.

The first thing we need to do is to determine the flow to each basin.

Display Slide 34—Flow, Basin Rate, gallons per min.

$$\text{Q (basin), gpm} = \frac{\text{Q (plant), gpm}}{\text{2 basins}}$$

$$= \frac{\text{1042 gpm}}{\text{2 (basins)}}$$

$$= \text{521 gpm}$$

Our second step is to determine the Cross Sectional Area (CSA) of one basin in square feet.

Display Slide 35—Cross-Sectional Area (CSA) of one basin in square feet.

CSA, sq ft = 20 ft wide x 12 ft deep

= 240 sq ft

The last step requires us to determine the Mean Flow Velocity (MFV) in feet per minute per basin.

Display Slide 36—Mean Flow Velocity, ft/min.

$$\text{MFV, ft/min} = \frac{\text{521 gpm}}{\text{240 sq ft x 7.48 gal/cu ft}}$$

$$= \text{0.29 ft/min}$$

[Ask participants if they have any questions. Answer as needed.]

Weir Loading Rate

Weir Loading Rate (Weir Overflow Rate) Calculation

[Ask participants to read the problem and complete. After about 5 minutes,]

Display Slide 37—Given Statement for Weir Loading Rate Calculation.

[Read Given statement aloud.]

Display Slide 38—Problem Statement for Weir Loading Rate Calculation.

The first thing we need to do is to convert flow rate to gallons per day.

Display Slide 39—Flow Rate, gallons per day.

Q, gpd = Q, MGD x 1,000,000

= 1.5 x 1,000,000

= 1,500,000 gpd

Our second step is to determine the total effluent Weir Length (WL).

Display Slide 40—Total Effluent Weir Length.

WL, ft = 2 basins x 20 ft width x 1 launder/basin x 2 sides/launder

= 80 feet of overflow weir, total

The last step requires us to calculate the Weir Loading Rate (WLR) in gallons per day per foot of weir length.

Display Slide 41—Weir Loading Rate, gal/day/ft.

$$\text{WLR, gpd/ft} = \frac{\text{1,500,000 gpd}}{\text{80 ft total Weir Length}}$$

$$= \text{18,750 gpd/ft}$$

[Ask participants if they have any questions. Answer as needed.]

UNIT 3 EXERCISE: <u>10 minutes</u>

Word Box

a. Water temperature	k. Electrical charge of particle
b. Particle size	l. Environmental conditions
c. Inlet zone	m. Sludge
d. Detention time	n. Clarifiers
e. Gravitational settling	o. Surface loading rate
f. Particle shape	p. Sludge zone
g. Outlet zone	q. Settling zone
h. Relationship of downward movement of particle to forward flow velocity	r. Mean flow velocity
i. Rectangular basin	s. Weir loading rate
j. Circular or Square basin	t. Tube or Plate settlers

Use the Word Box above to complete the following:

1. Identify the four zones of a sedimentation basin.

Ans: c – Inlet zone

g – Outlet zone

p – Sludge zone

q – Settling zone

2. List four operating parameters important to sedimentation.

Ans: d – Detention time

o – Surface loading rate

r – Mean flow velocity

s – Weir loading rate

3. List the settling characteristics upon which the sedimentation process is dependent.

Ans:

a – Water temperature

b – Particle size

d – Gravitational settling

f – Particle shape

k – Electrical charge of particle

l – Environmental conditions

h – Relationship of downward movement of particle to forward flow velocity

Fill in the blanks:

4. The ***largest*** portion of the horizontal flow sedimentation basin is the settling zone.

5. If the motor is normally running and the sludge collector is not moving, the most likely cause of a clarifier sludge collector problem would be that a ***shear pin*** is broken.

6. A sludge collector device should move very ***slowly .***

7. Increase flow to the treatment plant will affect the settling tank in that the detention time will ***decrease*** and the overflow rate will ***increase***.

8. A series of thin parallel plates installed at 45-degree angle for shallow depth sedimentation are known as ***lamellar plates .***

9. Two methods if improving settling efficiency in a sedimentation basins are using tilted plates or ***tube settlers .***.

10. If the weir overflow rate for a clarifier is too ***high***, floc carry over will be observed.

*[Review Unit 3 **Key Points**.]*

This brings us to the end of Unit 3 – Sedimentation/Clarification. As we continue through the process flow, the next step is Filtration. Let's turn to Unit 4 – Filtration.

[Continue to first page of Unit 4. Workbook page contains References]

UNIT 4: <u>130 minutes</u>

Display Slide 42—Unit 4: Filtration.

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

- Define filtration as it relates to water treatment.
- Identify the four performance considerations of Filtration.
- Given the formula and required data, calculate each of the following: filtration rate and backwash rate.
- Explain the importance of good record keeping.

GENERAL OVERVIEW OF CONVENTIONAL FILTRATION: 10 minutes

In Unit 1 we learned the definition for Conventional Filtration. As a quick refresher: Conventional Filtration is a method of treating water which consists of the addition of coagulant chemicals, flash mixing, coagulation and flocculation, sedimentation, filtration and disinfection. We are going to begin this Unit by focusing on filtration.

Process Description

[Review the definition of Filtration as presented.]

Display Slide 43—Filtration Schematic (Figure 4.1 of participant workbook).

[Point to the slide to illustrate the flow of the filtration process and where the filter beds and impurities removal occurs.]

Filter Bed Materials

[Review material presented in participant workbook.]

Impurities Removed

[Review material presented in participant workbook.]

Filtration is both a physical and chemical process. The mechanisms associated with the actual removal of particles from the water are interrelated and complex.

Filtration Mechanisms

Physical and Chemical Process

For example, removal of turbidity from the source water is dependent on the following factors:

[Review material presented in participant workbook.]

Removal Processes

A popular misconception is that particles are removed in a filter by straining. However, straining refers to particle removal by passing a liquid through a filter with pore size smaller than the particles to be removed. In a water filter, most of the particles removed are much smaller than the pore spaces in the filter bed. In order for the filter to have high removal efficiency, several removal mechanisms occur. These include:

[Review material presented in participant workbook.]

Now that we have a general understanding of what a filter is and how it works, let's look at several different types of filters.

TYPES OF FILTERS: <u>10 minutes</u>

Filters can be categorized in different ways. The first is based on how the water moves through the media – Gravity or Pressure. Let's begin with Gravity Filters.

Gravity Filters

[Review definition in workbook.]

Slow rate gravity filtration is covered thoroughly in Module 17.

[Review material in participant workbook.]

Rapid Rate Gravity Filtration

[Review material in participant workbook.]

The second classification of filters is Pressure Filters.

Pressure Filters

[Review definition for Pressure Filters in workbook.]

Pressure Filters are just that, filters in which the water passes through the filter media under pressure rather than by gravity.

Precoat Filtration

This type of pressure filtration, also known as diatomaceous earth is covered in depth in Module 16. Let's quickly review. A swimming pool filter is a good example of this type of filter.

[Review material in workbook.]

Cartridge or Bag Filtration

The last type of filter we're going to mention is cartridge or bag filtration. Quite simply, this type of filtration uses replaceable cartridges or bags, not unlike the way most vacuum cleaners work, except this is with water. Again, this type of filter is covered in greater detail in Module 18.

For the remainder of this unit, we will generally be considering only the most common method of filtration in use today, rapid rate gravity filtration. Now, let's take a look at some methods of controlling the water flow through the filters.

FILTER CONTROL SYSTEMS: 5 minutes

Common Filter Control Systems

Regulating the flow of water through the filters is important to plant efficiency. It helps ensure that trapped solids don't become dislodged and reintroduced into the flow. Essentially there are two common filter control systems: One in which water passes at a constant rate, the other in which water passes through at progressively slower rates.

Constant Rate

[Review material presented in workbook.]

Declining Rate

[Review material presented in workbook.]

[***Instructor Note:*** *You may wish to sketch the 2 control systems on the board to help explain to the participants the differences between the modes of control. Be sure to include 1) the rate-of-flow control valve on the outlet of the constant rate filter sketch and explain that as the filter media clogs, the valve opens to maintain the set rate through the filter, and 2) the level probe above the media which maintains the constant head on the declining rate filter.]*

Now that we understand the 2 types of flow controls commonly used, let's consider some of the other filter components that are common to all gravity filters.

[Review key point.]

PERFORMANCE CONSIDERATIONS: 45 minutes

Filter Media

Earlier when we were discussing gravity filters, we talked about the filter media. We learned that the filtration rate is dependent on the media used. Let's take a closer look.

Filter Media Materials

[Review material in workbook.]

Filter Media Support

[Review material in workbook.]

With an IMS® cap, pores are small enough to retain the sand but permit passage of water and air through the Cap.

Media Characteristics

[Review material in workbook.]

Another performance consideration of filter media is the classification of the media. Four factors are reported for classifications: Effective size, uniformity coefficient, specific gravity and hardness.

Media Classification

*[Review key point and material on **Effective Size** in workbook.]*

- *[Regarding size of sieve opening you may wish to add:]*

This means, 90 percent of the particles (by weight) are larger than the sieve opening.

- *[Regarding operational problems you may wish to add:]*

Both times should be approximately equal and both are affected by chemical pretreatment. Poor pretreatment will often result in either early break through, rapid headloss, or both.

Uniformity Coefficient or UC is a ratio.

*[Review key point and material on **Uniformity Coefficient** in workbook.]*

The last two classifications of Media are **Specific Gravity** and **Hardness**.

*[Review key point and material on **Specific Gravity** and **Hardness** in workbook.]*

Display Slide 44—Typical Filter Media Characteristics (Table 4.1 of participant workbook).

This table presents the four characteristics we just talked about for each of the media materials listed in the left column.

*[**Instructor Note:** Comment on the Table and observations of the table with items like: "note that generally the size of the media material gets smaller the deeper we go into the filter bed."*

With respect to UC, the number is the result of the calculation formula shown above. The lower the UC, the more uniform the particle size.]

The next performance consideration is that of Filter Underdrains.

Filter Underdrains

Display Slide 45—Filtration Schematic (Figure 4.1 of participant workbook).

Let's look at our Filtration Schematic once again. Although we will be looking at different types of underdrains, the operating principles are the same for all underdrains. Water goes in on the top of the filter, through the media and underdrain system and out of the filter for further processing. The backwash water is introduced to the underdrain system, up through the media and carries the captured material out of the filter via the wash troughs.

[Review material in workbook.]

Underdrain Types

Display Slide 46—Perforated Pipe Lateral Underdrain (Figure 4.2 of participant workbook).

[Point out on the slide the location of the filter media, waste gullet, pipe laterals and water trough. Follow the flow of water as you indicate each.

Flow enters the top of the filter (not shown on figure), flows downward through the filter media, enters the pipe laterals and then the manifold, and is carried out of the filter for further processing. In the backwash mode, the backwash water is introduced through the manifold and distributed across the bottom of the filter by the pipe laterals. It flows upward through the media, carrying away the retained particles to the wash trough which discharges the backwash waste to the waste gullet.]

Display Slide 47—Wheeler Filter Bottom (Figure 4.3 of participant workbook).

[Point to the area where the blocks are (center right – white and gray squares. This is where the filter medium is.]

Display Slide 48—Wheeler Bottom Section (Figure 4.4 of participant workbook).

This is a cross section of what we were looking at in the previous slide. You can see clearly how the filter media is placed within the system.

Display Slide 49—Filter Block Underdrain (Figure 4.5 of participant workbook).

[Explain that this is a schematic for both types of filter block. Figure 4.6 of participant workbook offers an illustration of what the plastic filter blocks look like.]

Display Slide 50—Nozzle & Strainer Underdrain (Figure 4.8 of participant workbook).

[Explain this graphic to participants by pointing out that this is what the Nozzle and Strainer look like.]

Display Slide 51—Nozzle & Strainer Underdrain (Figure 4.7 of participant workbook).

[Explain to participants that this is the entire underdrain for the nozzle and strainer they just saw. Point out the nozzle media in the graphic.]

Before we go any further, we should define a few terms which plant operators use on a daily basis.

Filter Operating Parameters

*[Review the definitions for **Filter Production, Filtration Rate,** and **Filtration Efficiency** as presented in participant workbook.]*

*[After the definition of **Filtration Efficiency,** review the two key points on filtration effectiveness and efficiency.]*

Now that we understand that as the water moves down through the filter media, the media captures particles. As more water is filtered, more particles are retained within the filter bed. Eventually, these particles will pass through the filter media and be discharged in the filter effluent. Since the purpose of filtration is to remove this material, we do not want it to be carried through the filter. Therefore, before the particles are carried through the media bed, they must be removed from the filter media. Backwashing is the method we use to clean the media bed of the trapped material.

Backwashing

*[Review definition for **Backwashing** in workbook.]*

[Review material in workbook regarding the purpose and process of backwashing.]

[Review material in workbook regarding typical backwash rates.]

[Review key point.]

One of the many responsibilities you have as a plant operator is to make sure the filtration process is running correctly, and as efficiently as possible. Filter efficiency is normally not mathematically calculated. Rather, an effluent turbidity value is selected (i.e., 0.1, 0.3 NTU) as an acceptable standard. When the measurement of effluent turbidity exceeds this value, the filter is backwashed.

The next section of the unit will provide each of you with the opportunity to perform some calculations for the filtration process. For each calculation, you will be given a scenario similar to what you might find at your plant. Let's turn the page and get started.

UNIT 4 EXERCISE: 15 minutes

1 – 4. There are four performance considerations of Filtration listed below. Match each consideration with the correct explanation of that consideration.

Ans:

Performance Consideration	Explanation
Filter Media	Filter production and efficiency
Filter Underdrains	The materials used to filter out impurities
Filter Operating Parameters	The process of reversing the flow of water back through the filter media to remove trapped material.
Backwashing	Where filtered water is collected during normal operation.

5. Write your own definition of **filtration** below.

Ans: Accept answers that include minimally: process, water moving through material, to remove impurities.

6. What are the reasons for keeping good records?

Ans: Accept reasonable answers.

Should include:

- for regulatory requirements,
- to provide a history – so you can
  - see what to expect,
  - plan for recurring cycles, etc.

This is where we will stop for this section of the course. When we return for the second half, we will begin by applying some of the skills needed in our work.

[Ask participants if they have any questions, prior to leaving. Thank them for their time and remind them to bring their materials when they return for the rest of the course.]

In our last session, we talked about Filtration, Filter Control Systems and Performance Considerations. During this session, we are going to look at calculations that operators might need to do in the course of their daily work.

PROCESS CALCULATIONS: <u>40 minutes</u>

Filtration Rate

[Review definition in workbook.]

Filtration Rate Sample Calculation

[Read the Given and Problem statements to the class.]

Given: A plant has four filters, each 22 feet wide by 25 feet long. When in operation, the plant treats a total flow of 10 million gallons per day.

Problem: Calculate the filtration rate.

[Review the calculations for solving the problems by working the problem through on the flip chart as indicated.]

Step 1 requires us to convert flow to gallons per minute.

Q, gpm = (Q, mgd x 1,000,000)÷ [(24 hr/day x 60 min/hr)]
= (10 x 1,000,000)÷ (24 x 60)
= 6945 gpm

Step 2 requires us to compute flow to each filter.

Q/filter, gpm = 6945 gpm ÷ 4 filters
= 1736 gpm/filter

Step 3 requires us to compute filter surface area in square feet.

A, sq ft = 22 ft wide x 25 ft long
= 550 sq ft

Now in Step 4 we can determine the filtration rate in gallons per minute per square foot.

Filtration Rate gpm/sq ft = Q/filter, gpm ÷ A, sq ft
= 1736 gpm ÷ 550 sq ft

Ans: = 3.16 gpm/sq ft

[Ask if there are any questions. Answer as needed.]

Filtration Rate Calculation

[Read the Given and Problem statements to the class.]

Given: A plant has four filters, each 22 feet wide by 25 feet long. When in operation, the plant treats a total flow of 10 million gallons per day. The water level drops 2 feet in 5 minutes with the influent valve closed.

Problem: Compute the filtration rate.

[Ask participants to perform the calculation in the space provided. Allow approximately 5 minutes for class to complete task. Once it appears almost everyone is finished, present the problem and solution on the flip chart as indicated below.]

Once again, it took 4 steps to perform the calculation. Step 1 required us to compute the filter surface area in square feet.

A, sq ft = 22 ft wide x 25 ft long
= 550 sq ft

Step 2 required computing the velocity of the dropping water in feet per minute.

V, fpm = Water drop, ft ÷ Time, min
= 2 feet ÷ 5 minutes
= 0.4 fpm

Step 3 was the computation of the flow of water through the filter in gallons per minute.

Q/filter, gpm = V, ft/min x Area, sq ft x 7.48 gal./cu ft
= 0.4 ft/min x 550 sq ft x7.48 gal/cu ft
= 1646 gpm

And now in our final step, we put it all together by computing the filtration rate in gallons per minute per square foot.

Filtration Rate gpm/sq ft = Q/filter, gpm ÷ A, sq ft
= 1646 gpm ÷ 550 sq ft
Ans: = 2.99 gpm/sq ft

[Ask participants if they have any questions. Answer as needed.]

Now we're going to do some Backwash rate calculations. But before we do, let's quickly review the material in the workbook.

Backwash Rate

[Review definition in workbook.]

[Review material in workbook.]

Backwash Rate Sample Calculation

[Read the Given and Problem statements to the class.]

Given: A filter 26 feet wide by 30 feet long with the desired backwash rate of 18 gallons per minute per square foot.

Problem: Determine the required backwash pumping rate.

[Review the calculations for solving the problems by working the problem through on the flip chart as indicated.]

To solve this problem it took 2 steps. Step 1 required us to calculate the filter surface area in square feet.

A, sq ft = (length, ft) x (width, ft)
= (30 x 26)
= 780 sq ft

In our second and final step, we determined the required backwash pumping rate in gallons per minute.

Backwash Pumping Rate, gpm = Filter Area, sq ft x Backwash rate, gpm/sq ft
= 780 sq ft x 18 gpm/sq ft

Ans: = 14,040 gpm

[Ask participants if they have any questions. Respond as needed.]

For the next calculation, you will build on the one we just completed.

Backwash Rate Calculation #1

[Read the Given and Problem statements to the class.]

Given: A filter 26 feet wide by 30 feet long with the desired backwash rate of 18 gallons per minute per square foot (same as for Sample #1)

Problem: Determine the volume of water in gallons required to backwash the filter in Sample #1, if the filter is backwashed for 10 minutes.

[Ask participants to perform the calculation in the space provided. Allow approximately 5 minutes for class to complete task. Once it appears almost everyone is finished, present the problem and solution on the flip chart as indicated below.]

This calculation took 3 steps. The first step was to calculate the filter surface area in square feet.

A, sq ft = (length, ft) x (width, ft)
= (30 x 26)
= 780 sq ft (same as step 1 in previous calculation).

Step 2 was to determine the required backwash pumping rate in gallons per minute.

Backwash Pumping Rate, gpm = Filter Area, sq ft x Backwash rate, gpm/sq ft
= 780 sq ft x 18 gpm/sq ft
= 14,040 gpm (same as step 2 in previous calculation.

Our third and final step it to determine the required backwash water volume in gallons.

V, gal = Backwash Pumping Rate, gpm x Backwash Duration, min.
= 14,040 gpm x 10 minutes
Ans: = 140,400 gallons

[Ask participants if they have any questions. Answer as needed.]

We have one more backwash calculation to try.

Backwash Rate Calculation #2

[Read the Given and Problem statements to the class.]

Given: A filter 18 feet wide by 20 feet long with a backwash rate of 20 gallons per minute per square foot.

Problem: Determine the backwash rise rate in inches per minute

[Ask participants to perform the calculation in the space provided. Allow approximately 5 minutes for class to complete task. Once it appears almost everyone is finished, present the problem and solution on the flip chart as indicated below.]

This calculation took 4 steps. The first step was to calculate the filter surface area in square feet.

A, sq ft = (length, ft) x (width, ft)
= 20 feet long x 18 feet wide
= 360 sq ft

In Step 2 we determine the flow of water through the filter in gallons per minute.

Q, gpm = Backwash Rate, gpm/sq ft x A, sq ft
= 20 gpm/sq ft x 360 sq ft
= 7,200 gpm

Step 3 was calculating the velocity of the rising water in feet per minute.

V, fpm = Q, gpm ÷ (A, sq ft x 7.48 gal/cu ft)
= 7,200 gpm ÷ (360 sq ft x 7.48 gal/cu ft)
= 7,200 gpm ÷ 2693 gal/ft
= 2.67 ft/min

In our 4th a final step, we converted the rise velocity to inches per minute.

V, fpm = V, fpm x 12 in/ft
= 2.67 fpm x 12
Ans: = 32 inches per minute

[Ask participants if they have any questions about any of the calculations done thus far. Congratulate them for a job well done.]

RECORD KEEPING: <u>5 minutes.</u>

Record keeping is one of the most important administrative jobs required of plant operators.

Daily Logs

[Review material in workbook.]

[Review Unit 4 ***Key Points****.]*

This brings us to the end of Unit 4. Are there any questions on the material or calculations we've covered thus far?

[Answer questions as needed.]

Our last and final unit in this module is about the operation of conventional filtration facilities. The nuts and bolts of what a plant operator does daily.

[Continue to first page of Unit 5. Workbook page contains References]

UNIT 5: <u>150 minutes</u>

Display Slide 52—Unit 5: Operation of Conventional Filtration Facilities.

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

- Identify the five components of ***Normal*** Operations.
- Explain the importance of “jar testing” and describe how the test is performed.

NORMAL OPERATION: **40 minutes**

In the conventional filtration process there are five components of normal operation. The first of these is Process Performance Monitoring.

Process Performance Monitoring

Overview

[Review material in workbook.]

As you can see, monitoring is a critical component to plant operations. There are different ways we can monitor.

Monitoring Methods

[Review material in workbook.]

Monitoring Methods Continued.

We've talked about methods for monitoring different factors. Now let's look at monitoring the actual filtration process.

Monitor Filtration Process

[Review material in workbook.]

The second component of normal operations is Process Controls and Equipment.

Process Controls and Equipment

Let's take a look at some of the process adjustment which might be required.

[Review material in workbook covering calibration of instruments and process control adjustments which may be required. Explain the importance of each action listed.]

[Continue reviewing information, explaining the importance of each action listed.]

The third component of normal operation is Process Support Equipment.

Process Support Equipment

[Review material in workbook. Provide a short explanation of the function of each piece of equipment and why it is important in the overall plant operation process.]

The fourth component of normal operation is Housekeeping.

[Review material in workbook.]

As with any operation, housekeeping is an issue that must be addressed.

Housekeeping

[Review material in workbook. Provide examples of several normal housekeeping items that are routinely performed such as painting equipment, lubricating operators, grass mowing, etc. and discuss the importance of maintaining a clean, well maintained facility.]

The last component of normal operation is Laboratory Testing.

Laboratory Testing

Perform Required Laboratory Testing

The type of tests required depends on the source water and the type of treatment.

[Review material in workbook.]

Display Slide 53—Jar Test Stirrer Equipment (Figure 5.1 of participant workbook).

[Review material and procedure for performing the jar test as outlined in the workbook.]

Jar Test Procedure

[As you review the material on Preparation for the test in the workbook, you may want to add the following:]

- Preparing fresh chemicals is necessary to ensure accurate readings and to simulate as much as possible what would be added to the flow stream.
- Organize data sheets in such a way to help with calculations later.
- When determining what combinations of chemicals will be tested, you will want to consider the purpose of the testing. For example, the chemicals used to determine the chemical feed rates for flocculation will usually be different from those used for metals removal.

[Review the material on establishing dosage range.]

It is extremely important to maintain as much control over the testing as possible so that the information you gather is reliable. It can not be overemphasized—make only one adjustment (i.e., change only one variable) in any given test run. Accuracy is essential.

Once everything is ready, testing begins.

[Review the test procedure, step-by-step. Frequently ask participants if they have questions on the procedure.]

[Complete the review of the Jar Test Procedure. At the end of the review, ask participants if they have any questions regarding any of the five components of normal operation.]

START-UP AND SHUTDOWN PROCEDURES: 10 minutes

Although starting and taking units off line are generally not normal operating procedures, periodically, various units must stopped and restarted to perform other required work such as cleaning or equipment maintenance. Let's review some of the startup and shutdown steps involved.

Start–up Procedures

General Start-up Procedures

[Review material in workbook. Discuss why each step is important.]

Coagulation/Flocculation Equipment Start-up Procedures

[Review material in workbook. Discuss why each step is important.]

Sedimentation Equipment Start-up Procedures

[Review material in workbook. Discuss why each step is important.]

Sedimentation Equipment Start-up Procedures continued.

[Continue reviewing material in workbook. Discuss why each step is important.]

Filters Start-up Procedures

[Review material in workbook. Discuss why each step is important.]

Now let's consider some of the steps necessary for shutting down the various processes and equipment.

Shutdown Procedures

General Shutdown Procedures

[Review material in workbook. Discuss why each step is important.]

General Shutdown Procedures

[Continue reviewing material in workbook. Discuss why each step is important.]

Now let's take a closer look at shutdown procedures; those that are designated for specific processes.

Coagulation/Flocculation/Sedimentation Shutdown Procedures

[Review material in workbook. Discuss why each step is important.]

Filter Shutdown Procedures

[Review material in workbook. Discuss why each step is important.]

ABNORMAL OPERATION: 20 minutes

Sudden changes in the raw water or in the performance of the individual processes is an indication that the operator should review the plant operation and take the necessary steps to correct the problem.

Changes in Source Water Quality

[Review material in workbook. Provide some examples of what might cause a change in raw water quality, such as a sudden rainstorm resulting in increased turbidity.]

Increased Filtered Water Turbidity

Of course, the ultimate goal of the water treatment plant operator is to produce consistently high quality water. Increases in filtered water turbidity are an indication that the operator needs to evaluate the problem and take the necessary corrective actions.

[Review material in workbook. Provide several examples of commonly occurring problems and discuss with the class. Ask the participant s to participate with examples from their own experience.]

[Continue reviewing increased filtered water turbidity information.]

It is especially important to keep good records during abnormal operating events.

Record Keeping

[Review material in workbook. Ask the class to provide some reasons that good record keeping is important.]

CONVENTIONAL FILTRATION PROCESS TROUBLESHOOTING: 60 minutes

To summarize the items we have just covered under abnormal operations, troubleshooting tables have been provided on the next pages.

[Point out the format and layout of the tables. Note the following:

- *There is a table for each process. This is indicated both in the title and across the top of the table.*
- *The second row identifies what is listed in each column:*
    - *Column 1 – Problem*
    - *Column 2 – Operator Actions*
    - *Column 3 – Possible Process Changes]*

Conventional Filtration Process Troubleshooting Table
Source Water Quality

[Review material in workbook.]

[Discuss actions and process changes to several of the problems. Ask class for other examples from their experience.]

Conventional Filtration Process Troubleshooting Table
Process Quality—Coagulation/Flocculation

[Review material in workbook.]

[Discuss actions and process changes to several of the problems. Ask class for other examples from their experience.]

Conventional Filtration Process Troubleshooting Table
Process Quality—Sedimentation

[Review material in workbook.]

[Discuss actions and process changes to several of the problems. Ask class for other examples from their experience.]

Conventional Filtration Process Troubleshooting Table
Process Quality—Filtration

[Review material in workbook.]

[Discuss actions and process changes to several of the problems. Ask class for other examples from their experience.]

UNIT 5 EXERCISE: <u>20 minutes</u>

A. Write below the 5 components of *Normal* operations of conventional filtration.

Ans: ***Can be presented in any order:***

1. ***Process Performance Monitoring***
2. ***Process Controls and Equipment***
3. ***Process Support Equipment***
4. ***Housekeeping***
5. ***Laboratory Testing***

B. Circle all of the following which are indicators of abnormal operating conditions.

Ans:

9. Increased filtered water turbidity

12. Media cracks and shrinkage

13. Mud balls

14. Rapid filter headloss increase

15. Short filter runs

C. True/False Mark the following statements with at "T" for true or an "F" for false.

Ans:

T 17. Process performance monitoring is an ongoing activity for plant operators.

F 18. New analytical equipment never needs calibration.

T 19. Some plants use air scour during filter backwash.

F 20. Jar testing is only needed when a problem occurs.

T 21. Equipment maintenance is a routine operating procedure.

T 22. Good floc formation is an indicator of properly operating coagulation/flocculation equipment.

F 23. Filters only need to be backwashed when dirty.

F 24. Never take a filter out of service.

F 25. Media "boils" during filter backwash are an indication of proper cleaning.

F 26. Raw water alkalinity does not affect the water treatment process.

[Review Unit 5 ***Key Points****.]*

This brings us to the end of Unit 5 and Module 14. Are there any questions on the material or calculations we've covered?

[Answer questions as needed and dismiss.]