DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Safe Drinking Water

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TITLE:	Guidance for Filter Plant Performance Evaluations
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AUTHORITY:	Pennsylvania’s Safe Drinking Water Act (35 P.S. § 721.1 *et seq*.) and regulations at 25 Pa. Code Chapter 109
POLICY:	This document contains the guidance and procedures developed to guide and support staff implementation of the requirements for the surface water treatment rule under the safe drinking water program.
PURPOSE:	The purpose of this document is to establish a rational and reasonable basis for staff decisions in the field, which will promote quality, timely and consistent service to the public and regulated community.
APPLICABILITY:	This guidance will apply to public water systems providing filtration for surface water and groundwater under the direct influence of surface water as defined under the Pennsylvania Safe Drinking Water Act.
DISCLAIMER:	The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements. The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of the Department of Environmental Protection (DEP) to give the rules in these policies that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.
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DEFINITIONS:	See 25 Pa. Code Chapter 109

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Acronyms

AHT--Air Hold Test

AWWA--American Water Works Association

BOL--Bureau of Laboratories

CFE--Combined Filter Effluent

CIP--Clean-In-Place

CL--Control Limit

CT--disinfectant Concentration “C” x contact Time “T”

DEP or PADEP--Pennsylvania Department of Environmental Protection

DBP--Disinfection Byproduct

EPA or USEPA--United States Environmental Protection Agency

FPPE--Filter Plant Performance Evaluation

GUDI--Groundwater Under the Direct Influence (of Surface Water)

HAA5--Haloacetic Acids (five)

IESWTR--Interim Enhanced Surface Water Treatment Rule

IFE--Individual Filter Effluent

Log--Logarithm

LCL--Lower Control Limit

LRV--Log Removal Value

LT2ESWTR--Long Term 2 Enhanced Surface Water Treatment Rule

MCF--Membrane Cartridge Filtration

MCL--Maximum Contaminant Level

MF--Microfiltration

MIT--Membrane Integrity Test

mL/min--milliliters per minute

NF--Nanofiltration

NPDES--National Pollutant Discharge Elimination System

NSF--National Sanitation Foundation

NTU--Nephelometric Turbidity Unit

PDT--Pressure Decay Test

RO--Reverse Osmosis

SCADA--Supervisory Control And Data Acquisition system

SOP--Standard Operating Procedure

TDS--Total Dissolved Solids

TMP--Transmembrane Pressure

TOC--Total Organic Carbon

TTHM--Total Trihalomethanes

UCL--Upper Control Limit

UF--Ultrafiltration

UV--Ultraviolet (Light)

UVT--Ultraviolet Transmittance

INTRODUCTION

The FPPE is a method of determining the effectiveness of a water treatment plant in removing and/or inactivating pathogens and pathogen-size organic and inorganic particles from the incoming raw water. Of particular concern is the removal of microscopic particles down to the two-micron size. This level of filtration reliability is needed to ensure removal of pathogenic protozoan including *Giardia* and *Cryptosporidium*. Both pathogens provide a benchmark for a plant's capability of protecting consumers from waterborne diseases, since they are some of the more difficult pathogens to remove and inactivate.

The foundation of the FPPE program is built around optimizing plant performance through operational and equipment changes. Plant performance is measured using optimization goals. At present, these goals are more stringent than the regulatory requirements for surface water treatment plants. Optimized performance goals are important, because studies have shown that plants meeting these optimization goals are more likely to inactivate and remove microscopic pathogens through their treatment plant and protect their customers. Waterborne disease outbreaks have occurred at surface water systems that met regulatory requirements; therefore, the optimization goals of a FPPE assists in providing a higher level of protection against outbreaks.

The evaluation process combines an on-site survey of plant operations and general physical conditions and involves sampling the facility's raw water for subsequent microscopic evaluation in the laboratory. Each plant is rated as "**Commendable**," "**Satisfactory**," or "**Needs Improvement**" based on the plant's ability and operators' skill level to maintain optimal performance on a long-term basis. Note that this rating is based on plant optimization as measured by the FPPE program. Although FPPEs may discover major treatment problems or identify and record violations of regulations, the rating system is not based on regulatory compliance. Technical assistance for improving the plant's performance is also provided by the FPPE program.

The on-site evaluation is a team effort shared by central office and field operations staff to review the operational processes and physical characteristics of a filter plant. By implementing a team evaluation, the exchange of information and findings pertaining to the facility and its operation can occur among the regional FPPE staff, the district sanitarian, the regional engineer, central office staff, and the facility operator. This team effort ensures understanding of existing problems and violations so that changes necessary to promote sound filter plant operation, maintenance, and performance are clearly understood.

OPTIMIZATION GOALS

The optimization goals shown in Table 1 are another tool used by the FPPE team to assess the performance at surface water treatment plants. FPPE staff should consider whether the water system has incorporated performance goals into their policies and standard operating procedures. FPPE staff should also determine if the water system has developed action plans to solve any performance problems.

FPPE staff should review the most recent twelve months of data against the optimization goals. Pay special attention to performance throughout the plant during periods of high raw water turbidity, cold weather, and any time water is more difficult to treat. Operator preparedness, reliability, and complacency should also be evaluated.

Table 1. Optimization Goals

Water Plant Process	Optimization Goals
Raw Daily maximum readings for the most recent twelve months chosen from 15-minute readings.	• This raw water turbidity data point is necessary in order to determine if sedimentation process is meeting optimization goals.
Sedimentation Evaluate the 95% of daily maximum readings for the most recent twelve months. Daily maximum data points should be chosen from 15-minute readings.	• Continuous, stable performance regardless of variations in raw water quality. Sedimentation performance should always show a reduction in turbidity when compared to the raw water. • Effluent turbidity <1.0 NTU, if annual average of daily maximum raw is <10 NTU (chosen from 15-minute readings) • Effluent turbidity <2.0 NTU, if annual average of daily maximum raw is >10 NTU (chosen from 15-minute readings)
Filtration (IFE and CFE) Evaluate the 95% of daily maximum readings for the most recent twelve months. Daily maximum data points should be chosen from 15-minute readings.	• Continuous, stable performance regardless of variations in raw and settled water quality. • Effluent turbidity <0.10 NTU
Recycle	• No recycle, <5% instantaneous flow if needed
Filter Bed Expansion	• 20% to 30%
Media Coating	• <5% media coating by weight
Filtration Backwash Recovery Evaluate individual filter profiles. Time period should bracket backwash at normal filter runtime.	• With filter-to-waste capability: Return to service when turbidity <0.10 NTU and remain <0.10 NTU for the entire filter run. • Without filter-to-waste capability: Recover to <0.10 NTU within 15 minutes and remain <0.10 NTU for the entire filter run.

Membrane Filtration	Optimization Goals
Indirect Integrity Goal	• Turbidity ≤ 0.05 NTU from continuous on-line monitoring.
Direct Integrity Goal	• LRVambient ≥ 4.0-log at 3 micron resolution limit and ≥ the minimum Log Removal required by the regulation agency.
Restoration of Membrane Permeability	• Permeability ≥ 90% after each CIP • Based on a baseline permeability determined for each membrane unit upon initial module installation and after a period of conditioning. The reference permeability and the post-CIP permeabilities are normalized to 20°C. • Restoration of membrane permeability is a measure of how effective the cleaning restores normalized permeability (M_{20}) back to its original state.

Entry Point	Optimization Goals
Giardia Log Inactivation	• > 1.0 Log Inactivation post filtration.
Plant Effluent Disinfection Byproducts (DBPs)	• Maintain disinfection byproduct concentrations of ≤ 20 µg/L for TTHM and ≤ 15 µg/L for HAA5. • For systems in compliance with the TTHM and HAA5 MCLs, collect quarterly plant effluent DBP samples; for systems not in compliance, collect monthly plant effluent samples.

Plants that utilize Chloramine	• Maintain a detectable free ammonia residual in the plant effluent ≤ 0.10 mg/L as NH3-N.
	• Monitor free ammonia at least once per day in the plant effluent.
	    • The monitoring frequency may be adjusted based on the variability observed over an extended period of time.
	    • Free ammonia may be monitored in the source water periodically (e.g., once per week) to assess variability.

Plants that utilize Chloramine	• Maintain a chlorine-to-nitrogen mass ratio between 4.5:1 and 5.0:1 (or chlorine-to-ammonia mass ratio between 3.7:1 and 4.1:1), which should result in a detectable free ammonia in the plant effluent that is ≤ 0.10 mg/L as NH3-N.

PERFORMANCE RATING SYSTEM

FPPE staff will use the following categories to rate each plant. The ratings are based on the plant's ability and operators' skill level to maintain optimal performance over the long-term. Please note that while FPPEs may discover major treatment problems or identify and record violations of regulations, the rating system is not based on regulatory compliance.

"Commendable"

Department staff have identified only minor operational, equipment, and/or performance problems that may affect the plant's ability to maintain optimized performance. Plant personnel have already taken steps to improve overall filter plant performance and maintain the long-term reliability of the plant.

"Satisfactory"

Department staff have identified operational, equipment, and/or performance problems that may affect the plant's ability to maintain optimized performance. Plant personnel appear willing and capable of improving overall filter plant performance. However, one or more of the treatment processes showed areas of weakness in operational, equipment, and/or performance that, if corrected, will improve filter plant performance and maintain the long-term reliability of the plant.

"Needs Improvement"

Department staff have identified considerable operational, equipment, and/or performance problems that are affecting the plant's ability to maintain optimized performance. Limitations are apparent that hinder improvement of overall filter plant performance. Areas of weakness affect the capability and dependability of the plant in providing consumers with an adequate level of protection against waterborne pathogens.

FPPE PROCESS

It's important for FPPE findings to be provided to water suppliers in a timely manner so that performance limiting factors and violations (if any) can be corrected and public health protected as soon as possible. Table 2 shows a FPPE Process Timeline example which provides a 3-week turnaround. Typically, FPPE findings are presented both in the form of a power point presentation and in a written FPPE report during a meeting between DEP staff and water supply operators and managers. Experience has shown that it is important for water supply managers and board members to be included in this meeting as these personnel are often important decision makers when it comes to addressing FPPE findings.

Table 2. FPPE Process Timeline

FPPE Process Timeline							
	FPPE Staff	**Sanitarian**	**Regional Engineer**	**CO Staff**	**Compliance Specialist**	**Operations Chief and/or Sanitarian Supervisor**	**Capacity Development Facilitator**
Week 1							
Monday	Advanced Preparation	Advanced Preparation	Advanced Preparation	Advanced Preparation			
Tuesday	On-site FPPE*	On-site FPPE*	On-site FPPE*	On-site FPPE*		Available for consultation	Available for consultation
Wednesday	On-site FPPE* and Schedule Exit Meeting	On-site FPPE*	On-site FPPE*	On-site FPPE*		Available for consultation	Available for consultation
Thursday	FPPE Findings to DEP Staff and Internal Regional FPPE Debrief	Internal Regional FPPE Debrief	Internal Regional FPPE Debrief		Internal Regional FPPE Debrief	Internal Regional FPPE Debrief	
Friday	FPPE Report Writing	Inspection Report Documenting any Deficiencies/Violations Provided to System*			Draft NOV if Violations Found During FPPE**		
Week 2							
Monday	FPPE Report Writing				Draft NOV if Violations Found During FPPE**		
Tuesday	FPPE Report Writing				Draft NOV if Violations Found During FPPE**		
Wednesday	FPPE Report Writing				Draft NOV if Violations Found During FPPE**		

Thursday	Share Draft FPPE Report	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	
Friday	Prepare Exit Meeting Presentation	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	
Week 3							
Monday	Prepare Exit Meeting Presentation	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	Draft Review and Comment	
Tuesday	Finalize FPPE Report and Prepare Exit Meeting Presentation				Finalize NOV**		
Wednesday	Finalize FPPE Report and Prepare Exit Meeting Presentation				Finalize NOV**		
Thursday	Present FPPE Exit Meeting Presentation to System Staff. Provide system with Final FPPE Report	Attend FPPE Exit Meeting Presentation w/ System Staff	Attend FPPE Exit Meeting Presentation w/ System Staff	Attend Exit Meeting for Needs Improvement Plants	Attend Exit Meeting for Needs Improvement Plants and Provide NOV to System**	Attend Exit Meeting for Needs Improvement Plants	Attend Exit Meeting for Needs Improvement Plants
Friday							

* Any Tier 1 Violations Identified During the FPPE Require Immediate Follow-up per Tier 1 Time frame.
** If Sanitarian is on-site and produces inspection report via mobile platform, violations will be automatically generated.
Important Note: *FPPE staff should coordinate with their direct supervisor and Regional SDW Program Management to discuss implementation of the above timeline to whatever extent feasible based on current regional SDW priorities & staffing resources. This is provided as guidance, respectful of the importance that Regional SDW Management staff should oversee final decisions relative to work assignments for their specific staff. As an example, minor adjustments may be made to this timeline to accommodate holidays, staff training, BOL sample turnaround, and exit meeting dates that work for key personnel.*

STAFF ADVANCED PREPARATION

Listed below are typical advanced preparation responsibilities for regional FPPE staff, district sanitarians, regional sanitary engineers, and central office staff.

REGIONAL FPPE STAFF:

- A FPPE should be conducted every 3 years for each facility. Wait one year after operations permit is given before conducting the first FPPE so you can graph a full year of data. FPPE staff should participate during the pre-operations inspections for new filtration facilities.

- Maintain a running 12-month FPPE calendar that lists the filter plants and tentative evaluation dates. FPPE staff should work with the FPPE supervisor to update the schedule in early July, and again in early January, to accomplish 15 FPPEs each state fiscal year per staff person. Discuss your FPPE calendar with your supervisor and share with regional and central office staff.

- Coordinate evaluation schedules with the sanitarian, central office, and regional engineer. Consider including the source water protection person and capability enhancement facilitator. Try to schedule 2-3 weeks prior to the scheduled dates to arrange arrival times and discuss the FPPE activities.

- Contact the public water system to arrange the FPPE and ensure that a certified operator and/or operator in responsible charge will be available. Briefly explain the procedure and necessary sampling points to the chief operator or superintendent. Individual filter taps will be needed, and the samples will be collected over a period of at least 24 hours so that critical stages of the filter run can be sampled. With the operator, establish sampling locations and arrange to include a backwash cycle during the sampling run.

- Consider conducting a pre-visit to any new facility to verify sample tap locations, general layout of the facility, and retrieving data not yet provided.

- Contact the BOL's *Giardia* lab to reserve raw water Method 1623.1, and any other special sample reservations.

- Review the latest inspection & sanitary survey (public water system inventory), current compliance documents, and previous FPPE reports to become familiar with the treatment plant and operational practices.

- Review the public water system's permit, including permitted capacity and any special operational conditions.

- Verify that all evaluation equipment is calibrated and verified according to manufacturer's recommendations, department guidance and in good working condition.

- Request and review the most recent 12 months of daily maximum raw, settled, IFE and CFE turbidity data and the most recent 12 months of daily minimum *Giardia* Log inactivation values and supporting process control data. If a system already submits turbidity data through

WebOAS or *Giardia* Log Inactivation values through DWELR, refer to the internal site for this information.

- Request the most recent reporting month of continuous IFE and CFE turbidity data and continuous entry point disinfectant residual data which was used by the system for compliance determination and DWELR reporting. Note that IFE and CFE turbidity data should represent water quality produced to the system so that a compliance determination can be made. Turbidity data representing backwashes, filter-to-waste, and data collected while the filters or plant are offline should either be clearly identified or removed from the data submittal. This data should be reviewed by FPPE staff prior to the on-site FPPE and compared to the information that the water system reported to DWELR.

- Request and review plant alarm set points and shut-off set points for turbidity, chlorine residual and clearwell levels. These values must then be verified on site.

<u>DISTRICT SANITARIAN:</u>

- Review the facility files to become familiar with the treatment plant, operational practices, system deficiencies, seasonal turbidity trends, and water quality history.

- Discuss with FPPE staff, the last 12 months of violation history at the plant to include any potential and unresolved violations, public notices required, recent equipment improvements, and general background information.

- Prepare to assist in assessing the treatment processes and water quality characteristics, and remain part of the evaluation team during the entire evaluation process.

<u>REGIONAL ENGINEER/TECHNICAL SERVICE STAFF:</u>

- Review the public water system's permit and Request of Designation of Treatment Segments for Calculation of 1.0-log *Giardia* Inactivation form.

- Verify the plant's chlorine dosage rate capability in milligrams per liter (both pre and post-chlorination). Review tracer study data including approved baffling factor(s), contact time of the treated water and *Giardia* inactivation values prior to reaching the first customer. This information helps prevent unnecessary boil water advisories or last-minute confusion in the event of a breakdown in treatment.

- Prepare to assist the evaluation team during the entire evaluation process.

<u>CENTRAL OFFICE STAFF:</u>

- Prepare to assist regional FPPE staff as needed.

- Calibrate and maintain full set of FPPE equipment, supplies and tools to be used as a backup if needed.

- Prepare to assist the evaluation team during the entire evaluation process.

STAFF ON-SITE ACTIVITIES

Listed below are expected on-site activities for staff during the Filter Plant Performance Evaluation:

REGIONAL FPPE STAFF:

- Responsible for taking the lead on the evaluation.
- Makes sure that equipment setup is properly completed in a timely manner. Makes sure that the line of questioning with the operator(s) is relevant to the operations of the treatment plant.
- Identify all critical sampling needs.
- Conduct plant tour, ask operational questions, review status of previous FPPE comments…(see Plant Operations Evaluation section of this report)
- Compare notes with other FPPE team members to generate a complete list of all preliminary FPPE findings.
- Ensure that the sanitarian, sanitarian supervisor, and any other appropriate department staff have been notified of any system deficiencies/violations noted during the FPPE. In situations when operational problems seriously affect the finished water quality (i.e. Tier 1 situations), violations and compliance issues must be promptly noted and appropriate actions must be taken per field related compliance strategy.
- Verbally share preliminary FPPE findings with lead operator and utility manager. Note that there will likely be additional FPPE findings after BOL sampling results are received and after all data has been trended and reviewed.
- Schedule an exit meeting with plant staff to present and discuss the final FPPE report. The meeting should include any relevant DEP staff, operators, supervisors as well as Borough or Authority members.

DISTRICT SANITARIAN:

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- Attend FPPE.
- Document the system deficiencies/violations identified during the FPPE in an inspection report.
- Assist with equipment set-up.
- Assist with sample collection and shipment.

REGIONAL ENGINEER:

- Verify that the water treatment plant achieves the required “Log inactivation” of *Giardia* cysts.

- Verify that the water treatment plant meets design standards.
- Answer permit related questions.
- Verify status of recent/proposed permit changes.
- Identify and discuss any potential permit modifications.
- Verify all treatment chemicals and processes are documented in the system's permit.

CENTRAL OFFICE FPPE STAFF:

- Prepare and train new FPPE staff.
- Assist regional FPPE staff with the evaluation. Help the FPPE staff with equipment setup, sampling, photo documentation and note taking.
- Observe the evaluation process for quality control and state-wide consistency purposes.
- Introduce new evaluation tools and techniques.
- In situations when operational problems seriously affect the finished water quality (i.e. Tier 1 situations), Technical Assistance Section Chief must be briefed of situation.

STAFF FOLLOW-UP ACTIVITIES

Listed below are typical follow-up activities for staff after the FPPE occurs:

REGIONAL FPPE STAFF:

- Write an email with any preliminary findings (both compliance and optimization) that were discovered and discussed when on site. Findings should be sent to all pertinent regional and central office staff.

- Write the draft FPPE report during the 2-week period immediately following the FPPE; send an electronic copy of the draft report to the appropriate central office and regional staff for review and comment. Highlight any special areas of concern, such as system deficiencies/violations. Do not share draft reports outside of the Department.

- Prepare the final report and a brief PowerPoint presentation to facilitate discussion of the FPPE comments. Send an electronic copy of the final FPPE report to appropriate central office and regional staff.

- Present and distribute the final FPPE report and key FPPE findings at the exit meeting in the form of a PowerPoint presentation. The final report should not be shared with the water system beforehand.

- Invite the Capability Enhancement Facilitator to the FPPE exit meeting when the plant rating is “Needs Improvement.” Invite the Source Water Protection Specialist to the FPPE exit meeting when the source(s) has an LT2ESWTR bin class of 2 or greater or there are other source water quality concerns.

- Request in writing that the water supplier provide the FPPE staff person with a written response that summarizes the suppliers plans for addressing each of the FPPE comments, including any unaddressed comments from previous evaluations. Request that the response be provided within 30 days.

- Review the water supplier’s response letter and share the letter with regional staff such as the sanitarian, supervisor, operations chief, compliance specialist, regional engineer, technical services chief and program manager. Bring attention to any response that is a concern or would need a reply from the Department. Notify your supervisor and the appropriate operations staff if a response letter is not received within the expected time period.

- A 1-year follow-up site visit should be scheduled for all “Needs Improvement” plants to review the water suppliers progress with addressing FPPE comments.

DISTRICT SANITARIAN:

- Ensure that violations and compliance issues are properly documented and addressed per field related compliance strategy.

- Review and comment on the draft FPPE report within timeframe requested by FPPE staff.
- Participate in FPPE exit meetings with water treatment plant staff.
- Review water supplier's written response letter.

REGIONAL ENGINEER:

- Follow-up with plant staff to resolve *Giardia* inactivation, design, and/or permitting issues.
- Assist the FPPE staff with *Giardia* inactivation calculations for inclusion in the FPPE report.
- Review and comment on the draft FPPE report within timeframe requested by FPPE staff.
- Participate in FPPE exit meetings with plant staff.
- Review water supplier's written response letter.

CENTRAL OFFICE FPPE STAFF:

- Review and provide comment on the draft FPPE report within timeframe requested by FPPE staff.
- Provide comments, which help to assure overall consistency of the program.
- Discuss and attempt to resolve any areas of concern or inconsistency with the FPPE staff.
- For "borderline" plants, help the FPPE staff to determine the most appropriate rating.
- Participate in FPPE exit meetings with the water supplier, if needed.
- Provide technical assistance where needed.

SOURCE WATER REVIEW

Discussion with the operator during the evaluation should focus on the characteristics of the raw water, possible points of contamination, and watershed control efforts. Specific areas of concern are nutrient control methods, algae control, sewage discharges, industrial uses, land uses, seasonal fluctuations in raw water quality (especially turbidity), and organic load variations. Try to identify the worst seasonal raw water quality problems and the corresponding operational changes made to deal with these problems. FPPE staff should describe and document the following:

- Source Water Protection plan and if it is updated annually
- 12 months of continuous raw water turbidity data for source water fluctuations

- Other source water monitoring used for process control (temperature, pH, alkalinity, UV254, etc)

- Source water parameters and values that would trigger operational staff to make a process control changes

- SOPs for source water management

- LT2ESWTR compliance status

PLANT OPERATIONS EVALUATION

The FPPE is a team participation process of sharing and collecting facility information and reviewing the overall operations and treatment processes to determine operational procedures and physical characteristics. Filter plant information is gathered and discussed among the district sanitarian, regional engineer, regional FPPE staff, central office staff, and plant operator(s) during the on-site evaluation. However, some information such as annual turbidity data, compliance history, log inactivation, and entry point chlorine residual information can be collected prior to the evaluation so that more time can be spent evaluating the operation of the filter plant. **Attachment 1** "**FORMULA SHEET**" contains formulas that are frequently used in the water industry and may come in handy during your evaluation.

When evaluating filter plants that have membrane, ultraviolet light, or ozone treatment processes, please refer to the following attachments for additional guidance as applicable:

- Attachment 3 MEMBRANE EVALUATION DURING FPPEs
- Attachment 4 ULTRAVIOLET DISINFECTION EVALUATION DURING FPPEs
- Attachment 5 OZONE EVALUATION DURING FPPEs

It is crucial that the FPPE be performed under "normal" operating procedures, so that representative data is collected. Therefore, do not request the operator to stray from the "normal" modes of operation to accommodate the FPPE. More specifically, operators should not adjust filter runtimes, backwash sequences, flow rates, tank levels, or total hours of plant operation solely to accommodate a FPPE. However, a FPPE can be performed under abnormal raw water conditions in order to assess the plant's ability to respond to changing raw water conditions.

Any operational areas of strength or performance limiting factors that could affect water quality are recorded by regional FPPE staff for later use when completing the FPPE report. The following examples of activities and questions are usually considered when doing this on-site evaluation:

FACILITY PERMIT: Determine if the system is operating according to the permit and document any discrepancies.

- Review permitted source(s) and status.

- Verify treatment chemicals and treatment process are consistent with those documented in the permit.

- Verify permit conditions are being met.

- Verify that no treatment chemicals or processes are missing, by-passed, malfunctioning, or otherwise not being operated as designed and permitted.

- Verify that a valid water allocation permit exists for public water system withdraws from a surface water or GUDI source where required.

- If the water system discharges to the Waters of the Commonwealth, then document that a valid NPDES permit is in use. The appropriate regional clean water program management staff are to be notified in writing of any unpermitted discharges.

CHEMICAL PRETREATMENT AND PROCESS CONTROL: Discuss with the operator and observe chemical pretreatment, focusing on unusual circumstances. Note the following:

- Verify all treatment chemicals are National Sanitation Foundation (NSF), Underwriters Laboratory (UL), or equivalently approved for ANSI standard 60. Verify chemical storage containers are labeled correctly.

- Verify all chemicals have the required secondary containment.

- Verify that chemicals are stored separately per Chemical Compatibility Table (3940-FM-BSDW0559)

- Chemicals used and dosage rates, especially coagulant; dosage adjustment frequency; application points and thoroughness of mixing; and overall effectiveness of chemical application.

- Review how chemicals are mixed; inline static mixer, rapid mix, order of chemical addition, etc.

- Review the operator's coagulant control strategy; methods for making chemical adjustments and procedures for checking and confirming proper dosages.

- Establish what, if any, tests are used (including jar tests, dosage charts, streaming current detectors, zeta potential, filterability, etc.) and when and how the results of these tests are used.

- Review historic raw water turbidity data for turbidity fluctuations and ask the operator what treatment adjustments were made to accommodate the raw water changes. Check historical turbidity data to see if settled and filtered turbidity spikes occur at the same time as raw water turbidity spikes.

- Confirm the chemical feed equipment calibration frequency and verify that records are being kept.

- Assess whether high-quality source water or automatic dosage control lead to complacency in the operation and management of the water system.

- Ensure SOPs are available for all key treatment processes, followed by all operators, representative of actual operations and approved by the operator in responsible charge.

PROCESS MONITORING: Identify water quality monitoring points throughout the plant. Parameters such as turbidity, pH, alkalinity, disinfectant residual, and temperature are especially important, since they affect and/or are affected by pretreatment. These parameters should be monitored, at a minimum, in the raw, settled, filtered, and finished water.

- Document whether the operators have established performance goals for each treatment process.

- Determine whether management supports optimization goals.

- Assess if the operators use information obtained from process control monitoring to ensure that each treatment process is optimized.

- Determine whether operational guidelines and optimization goals are documented in SOPs. Assess whether SOPs are being followed by all operators and represent actual operations.

- Determine if public water supply records and data are being maintained per DEP requirements.

- Verify that the water system's chemical reagents have not expired.

- Verify that operators have adequate instrumentation available which is needed to maintain compliance and optimized performance. For Example;

    - pH meter with three-point calibration
    - Continuous online recording turbidimeters on raw, individual settled effluent, IFE and CFE
    - Continuous online recording disinfectant residual analyzer at the entry point
    - Continuous online recording disinfectant residual analyzer, flow meter, thermometer, pH meter and water level indicator at the end of each disinfection segment used for *Giardia* inactivation
    - Jar testing equipment

PRETREATMENT: FLOCCULATIONAND SEDIMENATION: Identify the characteristics of floc formation and sedimentation.

- Discuss with the operator what floc characteristics are expected.

- Document the type of sedimentation or clarification process used.

- Confirm that sedimentation occurs where intended for the type of facility.

- Determine frequency of sludge removal. Evaluate whether short-circuiting occurs.

- Look for floc carry-over to the filters, floc accumulation in backwash troughs, and check settled water turbidity.

- Confirm that the sedimentation effluent (top the filters) is consistently $\leq$ 2.0 NTU ($\leq$1.0 NTU if annual average raw water turbidity is $\leq$10 NTU) despite raw water turbidity fluctuations. This applies to all sedimentation and clarification process types.

- Review the raw and treated water TOC levels. Determine if TOC reduction meets requirements and optimization goals.

- Verify that individual settled water turbidity is continuously monitored and recorded.

- Verify data from settled water turbidimeters is recorded, kept, trended, reviewed by operators, and used for making process control decisions.

- Adsorption clarifiers: A clarifier wash should also be observed if possible; cycles/steps, flow and duration should be noted.

    - Review criteria and SOP for clarifier wash.
    - Check for even distribution of air and water wash.
    - The clarifier should be clean at the end of the wash.
    - Determine if the filter is taken offline during the clarifier wash. If so, determine if filter-to-waste is implemented when the filter is returned to service after wash.
    - Record settled turbidities when the clarifier is returned to service; take grab samples if necessary.

<u>FILTER RUNS:</u> Observe the filters during the filter run.

- Document whether filter effluent performance consistently meets the optimization goal of <0.10 NTU.

- Verify that filter effluent turbidity meets state and federal safe drinking water requirements.

- Determine normal or average filter runtime and what criteria the operator uses to determine when to backwash.

- Filter runtimes typically should be less than 72 hours in duration. When filter runs are too long there is a risk of driving particles deeper into the filter bed which can be difficult to remove during backwashing. Excessively long filter runs can also increase the risk of air binding. Air binding or uncontrolled air can damage the filter underdrains and disrupt gravel layers when backwashing.

- Turbidity, headloss, and time should be considered when establishing filter runtime.

- Observe filter effluent turbidities when the filter is returned to service.

- Determine whether filters are capable of filtering to waste at normal production flow rates.

- Note the frequency of start-up and shut down which can cause turbidity breakthrough.

- Note any start-ups or changes in flow on any filters that may result in pathogen breakthrough while the filter is in production.

<u>FILTER BACKWASH:</u> Use a high-power spotlight to observe the filter bed before, during, and after backwash cycle**.** Monitor thoroughness of cleaning, flow rate, dead spots, media “boiling”, mudballs, cracks, separation between filter bed and wall, debris, uncontrolled air, worm holes, mounding and filter media loss. FPPE staff should measure media expansion.

- Backwash cycles/steps, flow and duration should be noted. Record IFE turbidity, headloss, and filter runtime prior to observed backwash.
- Assess whether the filter have air scour, surface sweeps or manual hand raking during the backwash.
- Evaluate whether the air scour is evenly distributed across the filter.
- Assess whether surface sweep arms are rotating and spraying evenly. Verify the surface sweep arms are at the appropriate distance above the media (1-3 inches) and all nozzles work. Confirm surface accumulations are being broken up.
- Determine the source of backwash water and if there is sufficient supply and flow rate. Recommended rates are 15-20 gpm/sq ft.
- Observe whether other filters are affected during filter backwashes (examples: increased flow changes, greater loading, higher turbidity, higher headloss).
- Determine whether the operator can adjust backwash rates (examples: increase rate in summer and decrease rate in winter).
- Determine the current percent bed expansion during high rate of wash. Recommended 20-30 percent bed expansion goal. Review the filter bed expansion results from the past year.
- Look for uncontrolled air during the backwash (other than during air scour). Uncontrolled air can cause filter damage. It could be a sign of air binding, an air relief valve failure, or backwash foot valve failure.
- Determine where the wastewater goes (example: sewer, a drying bed, NPDES discharge, or a lagoon).
- Determine if the wastewater holding capacity is adequate (example: to hold multiple backwashes or enough settling time in the lagoon prior to recycling).
- Look for filter or clarifier media in the backwash lagoon which can be a sign of media loss.
- Evaluate the recycle process for where it is returned to the treatment process, instantaneous percentage of total plant flow, frequency, and whether it is impacting plant performance.
- Review and assess the systems filter bed evaluation program and results. Determine whether any filter deficiencies were identified and corrected.

<u>POST BACKWASH PERFORMANCE:</u> Identify how the operator determines when a filter can be put back online.

- Discuss what parameters are used to determine if/when the filter is ready to return to service.

- Investigate any practices used to minimize turbidity breakthrough when placing a filter back into service.

- Verify the FTW capability, duration, and flow rate.

- Determine the IFE turbidity the filter is normally returned to service. If the filter is returned to service above 0.10 NTU, determine if the FTW period can be extended until turbidity is <0.10 NTU.

- If the filter does not have FTW capabilities, discuss whether capital improvement plans include FTW capabilities, alternative methodologies used to minimize post backwash turbidity spikes and if the return-to-service turbidity spike is <0.10NTU.

- Investigate whether the system uses an Enhanced Terminal Sub-fluidization Backwash (ETSW) procedure and if so, how has this improved post backwash performance.

- Determine if a polymer filter aid is applied to reduce on-line turbidity spikes.

- Monitor if valves are ramped open slowly as opposed to fully opened.

- Document the FTW duration, filter effluent turbidity when filter was returned to service and the recovery time for the filter to return to the optimization goal of <0.10 NTU.

- Observe turbidity trends for fluctuations during the filter ripening process.

- Verify that FTW occurs at all filter start-ups and backwashes.

- Determine if the filter plant is capable of FTW on all filters at the same time when restarting the plant.

<u>**FILTER EVALUATION:**</u> All filter plants are required to perform routine filter evaluation activities, including annual filter inspections, media samples, filter profiles, valving, and quarterly media expansion measurements. See the Filter Bed Evaluation Program Requirements form for additional information which can be found at the following link:
http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=54639

- Filter inspections should only be done as part of a special study/training event and not during the FPPE. Central office staff will come out and do the evaluation with regional staff if needed.

- Review the annual filter bed evaluation results from the water supplier.

- Be aware of FPPE Safety Inspection guidelines when conducting a filter inspection. Refer to **Attachment 2 <u>"GUIDELINES FOR PERFORMING FILTER INSPECTIONS"</u>** for further information.

- Review and verify the media analysis results against the following specifications:

Characteristic	Filter Media Criteria for Sand and Anthracite
Effective size	within 10 percent of original design specifications
Uniformity coefficient	<1.7; preferably around 1.3 (<2.2 for high-density sand)
Acid solubility	<5 percent weight loss
Filter media depth	within 1 to 2 inches of original media depth
Media shape	jagged with no obvious rounding

Please reference AWWA B604 for Granular Activated Carbon (GAC) criteria.

<u>**Definitions**</u>

Effective size: The size opening that will just pass 10 percent (by dry weight) of a representative sample of the filter material; that is, if the size distribution of the particles is such that 10 percent (by dry weight) of a sample is finer than 0.45 mm, the filter material has an effective size of 0.45 mm.

Uniformity coefficient: A ratio calculated as the size opening that will just pass 60 percent (by dry weight) of a representative sample of the filter material divided by the size opening that will just pass 10 percent (by dry weight) of the same sample.

Acid solubility: The acid solubility test is performed by immersing a known weight of material in 1:1 hydrochloric acid (HCl) (made by combining equal volumes of 1.18 specific gravity HCl and H2O) until the acid-soluble materials are dissolved, then determining the weight loss of the material.

Media Coating Analysis: If the media's acid solubility is >5%, the acid containing the soluble coating is then analyzed for concentrations of aluminum, manganese, iron, and calcium. The purpose of this test is to identify the minerals that make up the media coating.

<u>**DISINFECTION:**</u> Confirm if the disinfection system is being properly operated, maintained and monitored. FPPE staff should:

- Review the *Giardia* log inactivation and entry point disinfection residual data for previous one-year and discuss any unusual performance with plant staff

- Verify that all disinfection segments used for *Giardia* inactivation are located prior to the entry point

- Document the amount of *Giardia* log inactivation for each pre and post filtration. Determine if at least 1.0 log *Giardia* inactivation is consistently achieved post filtration

- Determine all disinfection segments including the feed points, baffling factors, flow rates, volumes, pH, temperature, and disinfectant residual monitoring points used by plant staff for calculating *Giardia* inactivation

- Compare actual disinfection segments and operations with the system's permitted processes

- Evaluate how the system determines their *Giardia* log inactivation. The *Giardia* and *Virus* Log Inactivation Calculation tool (CT spreadsheet) should be used to calculate the current log inactivation of the plant while on-site. The *Giardia* and *Virus* Log Inactivation Calculation tool can be found at the following link: https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/DrinkingWaterMgmt/Regulations/Pages/Proposed-Disinfection-Requirements-Rule--.aspx

DISINFECTION BYPRODUCTS: Review disinfection byproduct data.

Guidelines for DBP Sampling During FPPEs

- FPPE staff sampling should be limited to only the Entry Point location for filter plants that have a DBP problem (i.e. recent MCL or OEL exceedance).
- Entry Point DBP sampling should occur only during the May to November period when DBP formation is expected to be highest.
- TTHM and HAA5 sample bottles can be obtained from central office staff. FPPE staff should not order an entire case of sample bottles since only a few bottles would get used prior to them expiring.
- Sampling should not exceed 1 paired set of TTHM and HAA5 samples per FPPE.
- If entry point results exceed the respective TTHM or HAA5 formation goals, the water supplier should be expected to conduct additional investigative action.
- These results would be considered special sampling and not compliance sampling. The findings should be brought to the attention of other SDW staff in your region (e.g. ops and tech services).
- Water systems needing technical assistance related to disinfection byproduct formation and distribution system water quality should be referred to DEP's Distribution System Optimization staff.

FILTERED STORAGE: Evaluate the clearwell and any storage reservoir(s) before the entry point.

- Note any problems with the security or integrity of the filtered water storage that may allow recontamination to occur such as secured hatches and vents.
- Note dimensions, volume and type of storage at the water treatment plant, including the configuration of any baffling in the clearwell and storage reservoir, especially when used for log inactivation time.
- Determine how long the system can operate from storage capacity alone if the plant was offline because of an emergency (as low as possible without adversely impacting system pressure or fire protection needs).
- Determine the established inspection, cleaning and maintenance frequency for the clearwell and storage tanks at the water treatment plant.

<u>DATA INTEGRITY:</u> The FPPE staff's ability to effectively evaluate a filter plant is highly dependent on the availability of quality data. A "**Commendable**" rating should not be awarded if the integrity of the data is inadequate or in question. (For example: A "**Commendable**" rating should not be awarded if the plant's turbidimeters have not been calibrated per PA regulations.)

- Determine sampling locations of compliance and process control monitoring. For example, CFE monitoring should be a true combined effluent (not after the clearwell or any post treatment chemical addition) or a flow weighted average of the IFE's, if approved by the Department.

- IFE and CFE turbidity records should be available for at least the last 5 years. Chlorine data should be available for at least 3 years.

- IFE and CFE turbidity and entry point chlorine should be recorded at least every 15 minutes. If not, record the interval that the data is recorded.

- Determine if turbidity is being recorded during times when a filter is not in production. If so, determine when the filter is producing water to the system vs FTW, backwashing, calibrations, or offline. The hold outputs option should be for no longer than 15 minutes if it is used.

- Check for SOP regarding data deletion or invalidated. Verify who has authority to edit data.

- Ask the operator to retrieve data while on site to determine their ease of use and familiarity with reviewing data.

- Determine if plant staff review data trends and if they are used to make data-based decisions.

- Review the data for units. Determine if labels are correct and easily understood. (Example - NTU, gal/day, mg/L, psi/min)

- Determine if the data produced by the instrument matches the data being recorded. (Example: If the pressure gauge reads 25.55 psi, does the SCADA system display and record 25.55 psi?) If they do not, the 4-20 signal should be checked to verify the settings on the instrument output match the settings on the recording device.

- Verify data required in the permit special conditions are being reviewed, recorded, and reported.

- Daily data should represent maximum turbidity and minimum disinfectant residual that is reported through WebOAS and DWELR.

- Discuss any data gaps. Determine cause and look for any supporting data for that time period. Verify if the system reported the gaps to DEP within 24 hours.

- Compare previous month of SDWA-5 and SDWA-1 DWELR reporting with the actual continuous CFE turbidity values recorded by the plant. If comparison shows inconsistencies or violations, document them and try to determine why. Also determine who from the facility is responsible for reviewing turbidity data to determine compliance and who from the facility is responsible for DWELR reporting.

- Was the Department notified within 1-hour of discovery of any violations or situations noted in 109.701(a)(3)? Please see the Surface Water CWS One Hour Reporting Requirements Under 109.701(a)(3) poster located at the following link http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=3310

- Review turbidity and chlorine instrument calibration/verification information for;

  - Frequencies adequate per regulations/manufacturer recommendation
  - Cleaning and maintenance records
  - Primary standard use and expiration dates
  - One year of calibration/verification dates
  - All EPA Method 334.0 records
  - SOPs for calibration/verification, maintenance, and handling of data

- Determine if instrument readings are being checked, verified by operators and recorded into plant log sheets.

- Look for spare parts, calibration standards, reagents, and other instrument and recorder consumables. Determine if instrumentation repairs can be done in a timely fashion and/or if SOPs are available.

COMPLACENCY, RELIABILITY, AND PREPAREDNESS: Assess staff's ability to handle treatment difficulties during normal and unusual events. Determine if the importance of source water protection, pretreatment, and process control is completely understood by plant staff.

- Record the most recent date on the Emergency Response Plan.

- Verify if the water system has any policies or SOPs that lay out a plan on how to handle unusual events which could include periods of very poor source water quality, low finished water storage, and high demand.

- Document the date that the system's Uninterrupted System Service Plan (USSP) was last updated.

- Prior to the evaluation, review historical data to identify periods of poor source water quality, periods of treatment difficulties and interview plant staff to determine how they responded to these situations.

- Determine what they have done to address problematic events or improve their ability to do so.

MAINTENANCE: Discuss the facility maintenance with the operator and briefly review the supplier's O & M plan and records, focusing on critical areas of maintenance that affect plant performance.

- Document the date that the system's Operations and Maintenance Plan was last updated.

- Determine if the system has an Asset Management Plan. If so, document when it was last updated. Discuss how it is used to inform rate setting and capital improvements.

- Verify preventive maintenance is being practiced. Record frequency of maintenance being conducted.

- Determine if corrective maintenance frequency is adequate.

- Determine if predictive maintenance is used to identify future maintenance needs. (vibrating pumps, infrared analysis, leak detection, etc.)

- Verify the plant has adequate workspace and tools to perform maintenance tasks.

- Determine if plant staff are properly trained to perform maintenance.

- Ensure critical spare parts are stored at the plant or readily available.

OTHER IDENTIFIED PROBLEMS: Discuss conditions, which may have a negative effect on the overall filter plant performance. Attempt to determine general work environment. Determine if operators receive adequate training and administrative support/funding.

FPPE staff should consider action plans developed and past efforts taken by the plant staff to solve performance problems. Request that plant staff describe their efforts for improving plant performance. For example:

- Recognize performance problems

- Investigate causes of the performance problems

- Develop action plans to address the performance problems

- Follow best operational practices/preventive maintenance

- Maintain updated monitoring and maintenance records

- Modify operational practices to solve performance problems

For more detailed evaluation criteria, refer to American Water Works Association Research Foundation's "Self-Assessment Guide for Surface Water Treatment Plant Optimization" and "Filter Maintenance and Operations Guidance Manual".

SAMPLING FOR THE FPPE

The following samples and measurements should be taken by the regional FPPE staff with the assistance of the sanitarian, engineer, and water system operator. Document the sampling and field measurement information in at notebook for your recordkeeping. Fill out all Bureau of Labs (BOL) forms that will accompany the samples.

RAW WATER:

Method 1623.1 Sample –

- Fill a 10-liter cubitainer with raw water sample collected from a location before any treatment or recycle flow.
- Pack the 10-liter cubitainer in chest cooler w/ice. Store/ship sample at 33°F to 50°F. Do not allow the sample to freeze.
- Complete lab submission form and ship the sample to BOL the same day as collection.
- Note anything unusual in the comments section of the sample submission form.

Field Parameters - Measure and record the pH, temperature, disinfectant residual and turbidity at the sampling site using approved sample collection and analytical procedures.

Inorganics sampling analyzed by BOL – the sample sets for SAC 168 or 118 can be used to verify parameters you may not be able to take in the field. One 500 ml bottle and one 125 mL bottle with nitric fixative should be collected for each sample location.

MIXED, SETTLED WATER, IFE, CFE AND ENTRY POINT:

Field Parameters - Measure and record the pH, temperature, disinfectant residual and turbidity

Inorganics sampling analyzed by BOL – The sample sets for SAC 168 or 118. These may be taken from both the rapid mix stage and a post settled tap if there are chemical addition concerns.

INDIVIDUAL FILTER PROFILE

"A filter profile is a graphical representation of individual filter performance based on continuous turbidity measurements or total particle counts versus time for an entire filter run, from startup to backwash that includes assessment of filter performance while another filter is being backwashed"(EPA Guidance Manual for Compliance with the IESWTR, April 1999). Turbidity data is plotted on the Y-axis vs. time on the X-axis. A filter profile is a very useful tool used to assess the operation of an individual filter and the entire filter plant. A filter profile can point out factors that limit filter performance. A limiting factor could be anything that causes filter effluent turbidity to exceed the optimal performance goals. An exceedance of these optimal performance goals could indicate that one or more of the following limiting factors exist:

Table 3. Examples of Individual Filter Performance Limiting Factors

Limiting Factor	Indications
Excessive filter runtimes	Turbidity begin low and then exceed optimization goals prior to being backwashed.
Flow rate exceeds filter capacity	Turbidity break-through occurs during high flow conditions, post-backwash turbidity spike exceeds 0.10 NTU. Turbidity through at any time during the filter run.
Changes in flow rates	Turbidity break-through occurs during time of flow rate change. Filtration rates often increase on remaining filters, while one filter is being backwashed. Recycling events can also cause flow rates to increase. Seeking valves open and close to maintain desired flow rate.
Filter was not adequately backwashed	Turbidity break-through occurs just after a backwash and observation of filter backwash showed that water overflowing into the backwash troughs at the end of the backwash was still dirty and/or evidence of mud balls, post-backwash turbidity spike exceeds 0.10 NTU.
Filter-to-waste too short	Filter was put online while turbidity was above 0.10 NTU.
Physical problem with filter or underdrain	Turbidity break-through at any time during the filter run, including filter-to-waste, while other filters are performing fine. Turbidity during filter-to-waste should not exceed 0.3 NTU. This could indicate a problem with the filter, especially if other filters are performing fine.
Pretreatment not optimized	Overall filter performance is poor on all filters, evidence of sticky media, short filter runs; post-backwash turbidity spike exceeds 0.10 NTU. High headloss is also an indicator.

INTERPRETING PROFILES: A presentation called "**INTERPRETING FILTER PROFILES**" which contains example filter profiles and guidance for interpreting them can be found here:

https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/DrinkingWaterMgmt/Regulations/Pages/Interim-Enhanced-Surface-Water-Treatment-Rule.aspx

PROFILE DATA COLLECTION: The FPPE staff will choose a filter for profiling that is scheduled to be backwashed during the evaluation. When choosing a filter, FPPE staff should keep in mind that they will need sufficient time to setup their equipment (online turbidimeter,), allow stabilization and collect enough meaningful data prior to the backwash. If sufficient time and equipment is available, multiple filters may be profiled and evaluated. Turbidity data should be plotted approximately every minute to allow proper evaluation of filter performance. Longer intervals between data points would allow short periods of poor filter performance to go unnoticed. A shorter interval (<1 minute) creates an enormous amount of data that is very difficult to manage.

It is very important for the FPPE staff to be detail oriented and take thorough notes while collecting data for the filter profile. Periodically check the profile for turbidity spikes and other changes to turbidity while you are at the plant and especially when:

- other filters are being backwashed
- flow rates change
- chemical feed rates are adjusted
- recycling events occur
- raw or settled turbidities increase
- the filter is at the end of its runtime
- the start and stop of filter-to-waste
- the filter is placed into service after a backwash
- any time the filter is placed in or out of service
- the plant starts up automatically

If the cause of a spike is not obvious, record the time that the spike occurred and ask the operators if anything happened during that time period. Do this before you leave the plant, while everything is fresh in the operator's mind. Reference SCADA systems, strip charts, chart recorders, and operator log books in an attempt to gather information concerning the cause of filter profile spikes.

PROFILE LABELS: Individual filter profiles should have labels identifying when the filter backwash begins and ends, any filter resting periods, when the filter-to-waste begins and ends and when the filter is returned to service. Any spikes that exceed the optimal performance goals should be identified and explained in the text of the FPPE report.

FPPE REPORT WRITING

At the conclusion of the evaluation, the evaluation team will discuss apparent facility problems and serious conditions. Preliminary FPPE findings, deficiencies, and violations, especially **imminent threat violations,** will be noted by the sanitarian in an inspection report and provided to the water system. FPPE staff should follow up with internal DEP staff at the region and central office with an email listing all preliminary findings that will be in the FPPE.

Narrative discussion within the report should be kept to a minimum. The primary focus of the report is on the FPPE findings/comments and the data used to support the findings. An exit meeting should be scheduled while at the FPPE. The meeting should be held with the water system operators, managers, and board members. A PowerPoint Presentation should be developed to help facilitate discussion and understanding of the FPPE findings during the FPPE exit meeting.

INTRODUCTION:

- Facility background information
- FPPE Rating

PLANT SCHEMATIC:

- Include location of all disinfection segments, chemical feed points, flow meters, sampling locations (turbidimeters, chlorine analyzers, pH, temperature), pumps, and entry point location

FACILITY INFORMATION:

- Sources
- Plant Production
- Pumps
- Chemical Treatment
- Rapid Mix
- Flocculation
- Sedimentation
- Filtration
- Storage (Plant)
- Monitoring Devices

- Alarms and Shutdowns
- Operational Goals/Triggers
- Wastewater Disposal
- Certified Operators
- System Plans

PROCESS OBSERVATIONS:

- Graph one year of Raw, Settled, and Filtered turbidity data. Label any anomalies and add lines for optimization goals.
- Performance Data Summary
- Graph the turbidity data from the evaluation. Label any anomalies and add lines for optimization goals.
- Create a backwash turbidity graph with detailed labeling to show the influence the backwash procedure has on the filtered water quality.

DISINFECTION:

- Graph one year of minimum entry point chlorine data and *Giardia* log inactivation data. Make sure to spot check the plant data with the data that was submitted to PADWIS to verify accuracy and correctness of reported log inactivation. Only if there is concern, a worst case or emergency sample *Giardia* inactivation can be calculated for the system.
- Disinfection segments figure with baffling shown if appropriate
- Current system monitoring points
- Baffling factors
- *Giardia* log inactivation spreadsheet using data collected while on site

PHOTOS:

- Pictures of raw water particles from 1623.1 analysis
- Key pictures of notable issues, if applicable

COMMENTS:

- Performance rating
- Areas of operational strength, if appropriate
- Items addressed from past FPPE Reports. Actions taken to address any previous comments should be summarized and bulleted
- Previous comments that have not been addressed should remain in the report as original comments. Usually signified with the original year written before the comment or after the comment heading if there is one. For example; "(2014) Turbidimeters were not calibrated…" or "**Turbidimeter Calibration** (2014): Turbidimeters were not calibrated…"
- New Comments. New comments should include a heading to summarize the comment in a few words.

WATER QUALITY DATA AND EVALUATION INFORMATION: (Attach at end of report)

FPPE REPORTS AND OTHER SENSITIVE INFORMATION

FPPE reports contain sensitive information and should be marked "Confidential" and kept in the region's confidential file under lock and key. If the FPPE reports are requested by the public under the Right to Know Law or the Freedom of Information Act, the following information must be redacted from the report:

- Plant schematics
- Latitude/longitude or points on a map that indicate the location of source or treatment facilities
- Treatment process information and information regarding treatment chemicals
- System deficiencies that highlight security vulnerabilities

FPPE reports may be shared with the water system's staff and DEP staff. Consultants requesting FPPE reports on behalf of a water supplier should be directed to obtain a copy of the report directly from the water supplier.

OTHER DEP PROGRAMS

Based on the needs of the water treatment plant, you may wish to refer a water system to another DEP program. The following programs may be able to provide assistance to the water plant administration, management, or certified operators. Please note that participation in these programs is voluntary. Also remember to include the DEP staff person who is responsible for the water system when referring a system to one of these programs.

THE WATER OUTREACH ASSISTANCE PROGRAM: DEP uses peer-based trainers (water operators and other industry professionals) to provide on-site assistance to water systems with technical, managerial, and financial issues. Additional information can be found here:

https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/Pages/OperatorOutreach.aspx

CAPABILITY ENHANCEMENT PROGRAM: This program is designed to ensure the long-term technical, managerial, and financial capability of Pennsylvania's public drinking water systems. The Capability Enhancement Program often works in conjunction with the Water Outreach Assistance Program to improve operational issues. Examples of other assistance provided by the Capability Enhancement Program include leak detection, grant preparation, engineering services, and detailed business planning. Additional information can be found here: https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/CapabilityEnhancement/Pages/default.aspx

DISTRIBUTION SYSTEM EVALUATION PROGRAM: The aim of the DSE Program is to identify and address distribution system water quality limiting factors related to disinfectant residual, DBP formation, microbial activity, chemical characteristics, and operations. Additional information can be found here: https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/DistributionOptimization/Pages/default.aspx

THE PARTNERSHIP FOR SAFE WATER PROGRAM: The Partnership for Safe Water is a voluntary, cooperative effort of six US organizations dedicated to safe water. The program represents a partnership between regulators and water utilities. Participants in the Partnership for Safe Water adopt proven operational and administrative practices designed to improve surface water treatment plant performance. Please visit the following webpage for more information about the Partnership for Safe Water program: https://www.awwa.org/Resources-Tools/Programs/Partnership-for-Safe-Water

AREA WIDE OPTIMIZATION PROGRAM (AWOP): The Area Wide Optimization program is a multi-state effort in which states work together to develop and implement individual state programs to optimize particle removal and disinfection capabilities of surface water treatment plants in each state. Pennsylvania participates in AWOP by using WebOAS which allows water systems to provide daily maximum raw, settled and filtered turbidity information on a monthly basis. This information is then included on summary graphs and tables that facilitate the operator's ability to monitor long-term trends in the hopes of identifying problems early and verifying improvements made. Please visit the following webpage for more information about WebOAS: https://www.dep.pa.gov/Citizens/My-Water/PublicDrinkingWater/Pages/Electronic-Reporting-System.aspx

Attachment 1

Formula Sheet

Weight Measurement
Gallons water [50 F] x 8.3453 = pounds of water
Pounds of water x 0.1198 = gallons (gals)
Pounds of water x 0.0166032 = cubic feet (ft^3)
Pounds of water x 0.454 = liters (L)
Pounds of water x 0.454 = kilograms (kg)
Pounds of water x 454 = grams (g)
Pounds of water x 454,000 = milligrams (mg)

Length Measurement
Inches x 0.8333 = feet (ft)
Inches x 2.54 = centimeters (cm)
Feet (ft) x 0.0348 = meters (m)
Meters (m) x 3.28084 = feet (ft)
Feet(ft) x 5280 = miles (mi)

Pressure Measurement
Feet of water x 0.8826 = inches of mercury
Feet of water x 0.4335 = lbs. per square inch (lb/in^2)(psi)
Feet of water x 62.43 = lbs. per square foot (lb/ft^2)
Pounds per square inch (lb/in^2)(psi) x 2.307 = feet of water

Volume Measurement
Cubic feet (ft^3) x 7.48052 = gallons (gal)
Cubic feet (ft^3) x 28.317 = liters (L)
Gallons (gal) x 0.1337 = cubic feet (ft^3)
Gallons (gal) x 3.785 = liters (L)

Area Measurement
Acres x 43,560 = square feet (ft^2)
Square feet (ft^2) x 144 = square inches (in^2)
Square feet (ft^2) x 0.09290 = square meters (m^2)
Square inches (in^2) x 0.00695 = square feet (ft^2)
Square miles (mi^2) x 640 = acres
Square miles (mi^2) x 27,880,000 = square feet (ft^2)
Square miles (mi^2) x 3,098,000 = square yards (yd^2)
Square yards (yd^2) x 9 = square feet (ft^2)

Flow Measurement
Cu ft/ second (ft^3/sec) x 448.831 = gallons per minute (gpm)
Cu ft/second (ft^3/sec) x 0.646317 = million gals per day (mgd)
Gallons/minute (gpm) x .00223 = cubic feet per second (ft^3/sec)
Gallons/minute (gpm) x 1440 = gallons per day (gpd)
Gallons/minute (gpm) x 0.00144 = million gals per day (mgd)
Million gal./day (mgd) x 694.4 = gallons per minute (gpm)
Million gal./day (mgd) x 1.54723 = cubic feet per second (ft^3/sec)

Concentration Measurements
Parts per million (ppm) = milligrams per liter (mg/L)
Percent solution x 10,000 = milligrams per liter (mg/L)
Milligrams/liter (mg/L) x 8.345 = pounds per million gallons (lb/mil gal)
Pounds / million gallons (lbs/mil gal) x 0.1198 = milligrams/liter (mg/L)
Pounds per gallon (lbs/gal) x 119947.15 = milligrams per liter (mg/L)
ml/min x 1440 x .0002642 = gallons per day(gal/day)
gal/day x lbs. of chemical per gallon = lbs/day
lbs/day divided by MGD divided by 8.34 = mg/L

Temperature Equivalents
0.555 (°F – 32) = degrees Celsius (°C)
(1.8 x °C) + 32 = degrees Fahrenheit (°F)
°C + 273.15 = degrees Kelvin (°K)
boiling point = 212°F, 100°C or 373°K
freezing point = 32°F, 0°C or 273°K

Volume Formulas
Sphere volume, ft^3 = (4 x 3.14 x (radius, ft)^3)/ 3
Cylinder volume, ft^3 = 3.14 x (radius, ft)^2 x height, ft
Rectangle volume, ft^3 = length, ft x width, ft x height, ft
Prism volume, ft^3 = area of base, ft^2 x height, ft
Cone volume, ft^3 = 3.14/ 3 x (radius)^2 x height, ft

Area Formulas
Sphere area, ft^2 = 3.14 (diameter, ft)^2
Cylinder area, ft^2 = 2 x 3.14 (R)^2 + ((height, ft) x (3.14) x (diameter, ft))
Cone area, ft^2 = 3.14 x (slant height, ft) x (radius, ft)
Circle area, ft^2 = 3.14 (radius, ft)^2
Triangle area, ft^2 = ½ base, ft x height, ft
Rectangle area, ft^2 = length, ft x width, ft

Other formulas

Detention time, (min) = $\frac{\text{(volume, gal)}}{\text{(flow, gpm)}}$ or $\frac{\text{(volume, gal)}}{\text{(flow, mgd)(694.4, gpm/mgd)}}$

Surface overflow rate, (gpm/ft^2) = $\frac{\text{(flow, gpm)}}{\text{(length, ft)(width, ft)}}$

Filtration rate, (gpm/ft^2) = $\frac{\text{(flow, gpm)}}{\text{(surface area, ft}^2\text{)}}$

Dose, (mg/L) = $\frac{\text{(Chemical Feed, lbs/day)}}{\text{(Flow, mgd)(8.34 lbs/gal)}}$

Volume of a water main, (gal/ft) = .0408 x (diameter, inches)^2

Backwash rate 1 gpm/ft^2 = 1.6 inch/minute rise

Particle Counter - 2400P
- Flow rate must be 100 ml/minute
- Cell percentage should be >85%
- Clean sensor with brush and Liquinox after each evaluation

Surface Overflow Rates

Rectangular/Circular/Contact-	>14 ft	0.7 gpm/ft^2
	12 – 14 ft	0.6 gpm/ft^2
	10 – 12 ft	0.5 – 0.6 gpm/ft^2
	<10 ft	0.1-- 0.5 gpm/ft^2
Vertical (>45°) tube settlers	>14 ft	2.0 gpm/ft^2
	12 – 14 ft	1.5 gpm/ft^2
	10 – 12 ft	1.0 – 1.5 gpm/ft^2
	<10 ft	0.2 – 1.0 gpm/ft^2
Horizontal (<45°) tube settlers		2.0 gpm/ft^2
Adsorption clarifier		9.0 gpm/ft^2
Lamella Plates		4.0 gpm/ft^2
SuperPulsator		1.5 gpm/ft^2
With tubes		1.7 gpm/ft^2
Claricone	1.0 gpm/ft^2	

Filtration Rates

Sand media-	2.0 gpm/ft^2
Dual/Mixed media-	4.0 gpm/ft^2
Deep bed-	6.0 gpm/ft^2

Attachment 2

Guidelines for Performing Filter Inspections

PURPOSE:
The following is intended to outline accepted procedures for performing a filter inspection, as conducted by designated Central Office FPPE staff.

GENERAL:
- Filter inspections are one of many evaluation tools, they provide very valuable information, but safety is of utmost importance.
- Staff should use their discretion in deciding when to perform a filter inspection.
- If, for any reason, the task makes FPPE staff or plant personnel uncomfortable, the task should not be performed.
- Under no circumstances should FPPE staff perform an inspection alone.
- At least one other DEP staff must be present along with the plant staff responsible for operating the filter controls.

ENTRY/EXIT:
- Under no circumstances should FPPE staff enter a filter marked as a "confined space."
- Under no circumstances should FPPE staff enter a pressure, enclosed or "Permutit filter" (these filter types are confined spaces)
- Do not "hang and drop" into a filter.
- If the freeboard from where you are standing to where you will step/stand is more than shoulder height (or any distance which makes you uncomfortable) use a ladder or do not enter.
- If a ladder is used to enter, it should remain in place during the entire inspection to allow for a safe exit.
- When using a ladder, it should be placed on a piece of plywood or within a backwash trough for stability.
- Check the stability of the ladder before climbing.
- Additional DEP staff should hold the ladder whenever you are climbing on it during entry and exit of the filter.
- Most filter plants should have ladders available for use. (staff are not required to transport a ladder in the DEP vehicle)

SLIP/FALL:
- Slipping and falling is a risk within a water plant.
- Always wear proper footwear for filter inspections:
  - Rubber soled boots with good traction or
  - Felt bottom boots
- Use ladder as described in ENTRY/EXIT section above.
- Do not stand inside the filter box or in the troughs while a filter is backwashing.
- The retractable bed expansion-measuring device should allow measurement of bed expansions from outside the filter box.
- Contact CO if your measuring reel needs repaired or replaced.

FILTER DRAINED:
- Never attempt to step on the surface of a filter, which contains water.

- Only step onto the filter media after it is adequately drained.
- A filter is considered adequately drained when the water level has fallen below the support gravel layer.
- There are several ways to assure that the filter is adequately drained - it is suggested that you use at least two of the following methods before stepping onto the filter surface:
    - The operator draining the filter can normally provide you with an indication, based on flow, of when the filter is drained.
    - Use stainless steel probing rod to determine the depth of water below the surface of the media.
    - Often, a plant design will allow FPPE staff to hear when the water has stopped exiting the filter-to-waste drain. If the operator verifies that this drain valve is still open, then the filter should be adequately drained.
- Plywood squares can be placed on the media surface to make a walkway. This is not required but is suggested especially if the filter surface contains a thin layer of mud.

LOCK OUT/TAG OUT:

- Lock out/tag out procedures should be followed to reduce the risk of filter refill during the inspection.
- FPPE staff should use the custom lock out tags provided by CO.
- A wet-erase marker should be used to record the filter #, date, and time on the lock out tag.
- Lock out tags are re-usable.
- For plants with SCADA controls that allow remote operation of the filter, operators should place the local filter control on manual to prevent remote access. If this cannot be accomplished, it is important to make sure tags are also placed on the SCADA controls to prevent an operator from remotely opening valving to refill the filter.
- The operator that drained the filter should remain on-site during the inspection.
- Request that the operator on-site informs all other plant operators that the filter is drained for inspection and must not be refilled until the inspection is completed.

ATMOSPHERE:

- Industry experts have indicated that performing filter inspections, on freshly drained conventional anthracite or sand filters used for particulate removal at surface water filtration plants, does not present a significant risk for poor atmosphere.
- Therefore, always perform inspections on a newly drained filter. You should observe the filter draining while on-site.
- Never enter a filter that has been offline long enough for the media to completely dry.
- Filter media, especially GAC, may release adsorbed treatment chemicals ("off-gas") if it is allowed to dry.

SAFETY TRAININGS:

All FPPE field staff who will be performing filter inspections should attend the Department's Confined Space and all other applicable safety trainings. These trainings should be coordinated via the supervisor.

CONTACTS:

Questions regarding the above information should be directed to Central Office Technical Assistance Section.

Attachment 3

Membrane Evaluation during FPPEs

MEMBRANE TECHNOLOGY TERMS AND DEFINITIONS

Note: Most definitions came from the EPA Membrane Filtration Guidance Manual (EPA 815-R-06-009).

Cartridge – a disposable filter element; included under the term "module" for the purposes of the LT2ESWTR

Clean-In-Place (CIP) – the periodic application of a chemical solution or (series of solutions) to a membrane unit for the intended purpose of removing accumulated foulants and thus restoring permeability and resistance to baseline levels; commonly used term for in-situ chemical cleaning

Control Limit (CL) – a response from an integrity test, which, if exceeded, indicates a potential problem with the membrane filtration system and triggers a response; synonymous with upper control limit (UCL) as used in the Membrane Filtration Guidance Manual to distinguish from lower control limits (LCLs)

Crossflow – 1) the application of water at high velocity tangential to the surface of a membrane to maintain contaminants in suspension; also, 2) suspension mode hydraulic configuration that is typically associated with spiral-wound nanofiltration (NF) and reverse osmosis (RO) systems and a few hollow-fiber microfiltration (MF) and ultrafiltration (UF) systems

Direct Integrity Test (DIT) – a physical test applied to a membrane unit in order to identify and/or isolate integrity breaches (also known as a PDT or AHT)

Filtrate – the water produced from a filtration process; typically used to describe the water produced by porous membranes such those used in membrane cartridge filtration (MCF), microfiltration (MF), and ultrafiltration (UF) processes.

Flux – the throughput of a pressure-driven membrane filtration system expressed as flow per unit of membrane area (e.g., gallons per square foot per day (gfd) or liters per hour per square meter (Lmh))

Fouling – the gradual accumulation of contaminants on a membrane surface or within a porous membrane structure that inhibits the passage of water, thus decreasing productivity Heterogeneous – composed of a combination of different materials (e.g., composite and some asymmetric membranes)

Hollow-Fiber Module – a configuration in which hollow-fiber membranes are bundled longitudinally and either encased in a pressure vessel or submerged in a basin; typically associated with microfiltration (MF) and ultrafiltration (UF) membrane processes

Indirect integrity monitoring – monitoring some aspect of filtrate water quality that is indicative of the removal of particulate matter. In the context of indirect integrity monitoring, continuous is defined as a frequency of no less than once every 15 minutes (40 CFR 141.719(b)(4)(ii)).

Integrity breach – one or more leaks in a membrane filtration system that could result in the contamination of the filtrate with unfiltered feed water

Irreversible Fouling – any membrane fouling that is permanent and cannot be removed by either backwashing (if applicable) or chemical cleaning

Log Removal Value (LRV) – filtration removal efficiency for a target organism, particulate, or surrogate expressed as log10 (i.e., log10 (feed concentration) – log10(filtrate concentration))

Membrane Filtration – a pressure- or vacuum-driven separation process in which particulate matter larger than 1 mm is rejected by an engineered barrier, primarily through a size-exclusion mechanism and which has a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test.

Membrane Cartridge Filtration (MCF) – any cartridge filtration devices that meet the definition of membrane filtration

Membrane Unit – a group of membrane modules that share common valving which allows the unit to be isolated from the rest of the system for the purpose of integrity testing or other maintenance (sometimes referred to as a train, skid or rack)

Microfiltration (MF) – a pressure-driven membrane filtration process that typically employs hollow-fiber membranes with a pore size range of approximately 0.1 - 0.2 mm (nominally mm)

Module – the smallest component of a membrane unit in which a specific membrane surface area is housed in a device with a filtrate outlet structure; used in the Membrane Filtration Guidance Manual to refer to all types of membrane configurations, including terms such as cassette or cartridge that are commonly used in the membrane treatment industry

Permeability – the ability of a membrane barrier to allow the passage or diffusion of a substance (i.e., a gas, a liquid, or solute)

Permeate – the water that passes through a nanofiltration (NF) or reverse osmosis (RO) membrane; synonymous with the term filtrate, which is used in the context of the LT2ESWTR

Pore Size – the size of the openings in a porous membrane expressed either as nominal (average) or the absolute (maximum), typically in terms of microns

Porosity – for a membrane material, the ratio of the volume of voids to the total volume

Rack – a group of pressure vessels that share common valving and which can be isolated as a group for testing, cleaning, or repair; synonymous with the terms train and skid.

Recovery – the volumetric percent of feed water that is converted to filtrate in the treatment process over the course of an uninterrupted (i.e., by chemical cleaning or a solids removal process such as backwashing) operating cycle (excluding losses that occur due to the use of filtrate in backwashing or cleaning operations)

Skid – a group of membrane vessels that share common valving and which can be isolated as a group for testing, cleaning, or repair.

Specific Flux – membrane flux normalized for pressure and temperature

Train – a group of membrane vessels that share common valving and which can be isolated as a group for testing, cleaning, or repair; synonymous with the terms rack and skid; included under the term "unit" for the purposes of the LT2ESWTR

Transmembrane Pressure (TMP) – the difference in pressure from the feed (or feed concentrate average, if applicable) to the filtrate across a membrane barrier

Ultrafiltration (UF) – a pressure-driven membrane filtration process that typically employs hollow-fiber membranes with a pore size range of approximately <0.1 mm (nominally mm)

<u>INTRODUCTION</u>

Membrane treatment plants require additional review and attention during the FPPE. This attachment only covers the membrane related evaluation procedures; for all other treatment processes see primary protocol. This is especially important for the first FPPE at a membrane facility specific membrane trending data should include Flux rates, TMP, PDT, and LRV trends.

It may be beneficial to visit the membrane plant on a day a maintenance wash or CIP is on the plant's maintenance schedule or when the operators are performing sonic testing, bubble test, or pinning/repairs. This might be completed during the FPPE, but more likely at a follow-up visit to the plant.

The following are examples of activities and questions usually considered when doing this on-site evaluation:

<u>PREPARATION:</u> Follow guidance previously discussed in the primary FPPE Protocol. Preparation specific to membrane filtration may include:

- Special preparation and coordination with all FPPE team members may be needed for the first evaluation of a membrane plant.
- If not part of the monthly membrane reporting, request most recent annual data for PDT, LRV, and TMP in advance to give you time to graph and evaluate the data.
- Review the "Special Conditions" section of the permit.

<u>MEMBRANE SPECIFIC DATA GATHERING (on site):</u>

- Daily maximum flux rate in gfd
- Dates and times of FM and enhanced cleanings (EFM and CIP)
- Effluent pH and chlorine residuals following cleanings during past year

<u>MEMBRANE EVALUATION (on site):</u>

- Are special conditions being met?

- Are control limits programmed into the PLC and SCADA?

- Are alarms and shutdowns in place for membrane related control limits?

- Verify strainer type, number, micron size, and document automatic cleaning/flushing frequency and long-term strainer maintenance.

DIRECT INTEGRITY TESTING: Identify specifics of any direct integrity testing on membrane treatment units such a PDT and LRV calculations.

- Are test results recorded, maintained, trended on site through the membranes PLC and/or plants SCADA? Do the operators understand what the tests do and what the results mean?

- Are the special permit conditions for integrity testing being met?

  - What is the maximum direct integrity pressure?
  - Are LRV calculations determined during testing? How are they calculated?
  - Are there any plant specific forms/logs maintained regarding these tests?
  - Is the test reaching the required minimum starting pressure?
  - Is the starting pressure recorded?
  - How long is the test?
  - What triggers a failure?

- Are monthly PDT reports forms, Control Limit Exceedance forms, and LT2ESWTR Toolbox forms being sent to the DEP each month? Are they accurately filled out?

- What practices are completed if any of these integrity tests fail during normal operations?

- Identify any alarm set points for turbidity, LRV, start pressure, TMP, and PDR.

- Are PDTs performed following all non-routine shutdowns?

- Are there any written SOPs for operators to follow in the event of a failed PDT?

- Observe at least one (1) pressure decay test.

PRODUCTION CYCLE: Observe the membranes during production cycles.

- How are the membrane units operated regarding flow direction? Ex. Inside/Out, Outside/In?

- Are there air pulsing or agitation cycles during production cycle?

  - If so, is the air pulse cyclical or constant? Frequency and duration? Does this vary? If so, why?

- What is the design flux rate for the membranes? Is this flux rate maintained? Does the plant trend this data?

- Does membrane filtrate meet optimization goals of <0.05 NTU?

- Is the filtrate turbidity in compliance with the Pennsylvania Safe Drinking Water Requirements and permit special conditions?

- Determine normal or average production cycle length and what criteria the operator used to determine this.

- Are there any concerns that debris can damage the membrane fibers?

FLUX MAINTENANCE (NON-CHEMICAL CLEANING): This type of cleaning is used to remove floc and other loose particles from the membrane surface. Observe the backflow/reverse flush maintenance clean cycle, if possible.

- Does the membrane filter unit have a backflow/reverse flush cleaning cycle?

    - If so, what triggers it, duration and frequency?

- Is there a tank drain/deconcentrating cycle? (Submersed type membrane units only)

    - If so, what triggers a deconcentration cycle, duration, steps, frequency?
    - At what percent recovery does the deconcentration cycle take place?
    - Does the percent recovery change? If so, why?
    - How much water is wasted?
    - Where does the wastewater go?

- Is filtered/finished water used for the backflow?

ENHANCED CLEANINGS: This type of chemical cleaning is used to remove organic and inorganic fouling from the membrane fiber. Identify specifics about all additional membrane unit cleaning/maintenance procedures with respect to Enhanced Flux Maintenance (EFM) and CIP. All membrane plants should occasionally perform EFM or CIPs.

- EFM is less frequent and uses less chemical and CIP is more frequent and uses more chemical. The following evaluation questions should be relevant for both EFM and CIP.

    - How often are the EFM/CIP cleaning cycles performed? What triggers the EFM/CIP? Is it based on time, high TMP, or both?

    - What chemicals are used in the cleaning process? NSF Standard 60? Permitted? Dosages?

    - What are the water quality targets before and during the chemical cleaning? Does the operator check pH, temperature and chlorine residuals?

    - Are the cleaning solutions heated? Is temperature accurately monitored?

    - What type of fouling is occurring on the membrane units? Organic or Inorganic?

- Is the appropriate chemical used for the type of fouling?
- Do fouling and/or chemical cleaning processes change seasonally?
- Are there written SOPs for the EFM/CIP procedure? What are the steps?
- How many rinses are performed after each chemical cleaning?
- How does the operator check pH, chlorine residual or any other water quality parameters of filtrate rinse water before sending it to production?
- Are important details about EFMs/CIPs recorded? dates, time, chemicals used, monitoring results, was cleaning successful (TMP/permeability recovery)
- Consider returning to observe the process to verify actual EFM/CIP is performed according to SOPs. (not during FPPE)
- Was a PDT performed and passed prior to returning to service?
- Following cleaning is FTW conducted until <0.05 NTU?

<u>MEMBRANE MONITORING/REPAIRS/PINNING:</u> All membranes must occasionally be monitored for broken/damaged fibers. Monitoring and repairing broken fibers may include a variety of tools and techniques depending on membrane design. Monitoring may be performed using a bubble test, visual monitoring, sonic testing or similar methods. Repair work may include gluing, pinning, removal of the damaged fiber/section or similar repairs.

- What monitoring do operators perform to verify that fibers are intact? Do they have all necessary equipment?
- What triggers this monitoring? How often is it performed? Are accurate records kept?
- How do they determine if membrane fibers need to be repaired?
- How are membrane fibers repaired (pinning/gluing/removal)? Does the facility have all the necessary equipment and training?
- How often has this been done? What are the results?
- Does it seem excessive? Too many repairs (pretreatment/strainer issue)? Waiting too long between repairs?
- Are accurate records kept of all repair work?
- How many fibers can be repaired before the membrane cartridge/module must be replaced?

MAINTENANCE:

- Do they have vendor support? Is there a service and maintenance contract?
- What is the expected life of the membranes? Will the system have the ability to quickly replace membranes when needed or should a replacement fund be established?
- Have they had any valve/O-ring problems?
- Are pressure gauges verified for accuracy annually?

Attachment 4

Ultraviolet Disinfection Evaluation during FPPEs

Description of UV Treatment Process
UV light is electromagnetic radiation with wavelengths shorter than visible light and short-wavelength UV considered "germicidal UV". At certain wavelengths, UV is mutagenic to bacteria, viruses and other microorganisms. Particularly at wavelengths around 260 nm–270 nm, UV breaks molecular bonds within microorganismal DNA, producing thymine dimers that can kill or disable the organisms.

The effectiveness of germicidal UV depends on the length of time a microorganism is exposed to UV, the intensity and wavelength of the UV radiation, the presence of particles that can protect the microorganisms from UV, and a microorganism's ability to withstand UV during its exposure.

There are two methods that are used for measuring a UV reactor's performance. The **UV intensity set-point method** and the **calculated UV dose method.** It is important to determine early in the UV evaluation process which method is required. This information is typically found in the DEP permit. The method being used will determine the performance monitoring that is needed, and the Department UV forms that need to be completed. All the Department's UV MOR and reporting forms can be found on eLibrary.

Because of the newness of this technology, it is important to thoroughly prepare prior to the FPPE and in addition to the normal FPPE team members it would be important to include several staff member who are experienced with UV (regional engineer who permitted facility, central office staff).

<u>Advanced Preparation for UV Evaluation</u>

- Assemble all UV related permits/documents/records and consider having an FPPE team discussion.

- The UV special permit conditions may include but are not limited to:
    - minimum UVT set-point,
    - minimum UV intensity set-point,
    - minimum UV dose set-point,
    - maximum flow rate through the UV reactor,
    - % off-spec water set-point,
    - minimum frequency for UV intensity duty sensor verifications,
    - minimum frequency for UV intensity verification sensor calibrations,
    - cleaning and maintenance requirements,
    - data collection, recording, and reporting requirements

- Manufacturer specifications sheets and recommended maintenance
    - UV reactor
    - UVT analyzer
    - UV intensity sensor
    - Spectrophotometer

- Verify UV Monthly Operations Reports (MOR) for most recent 12 months were submitted to DEP.

- Request calibration records for UV intensity reference sensor for most recent 2 years.
- Request verification records for UV intensity duty sensor for most recent 12 months.
- Request Operations and Maintenance records relevant to the UV process and UV monitoring for most recent 12 months.
- Request any other UV performance data or trends used by plant staff for process control for most recent 12 months.

On-site Activities

- Verify all treatment technique requirements and permit special conditions are consistently being met.
- Interview the plant staff responsible for daily operations, recordkeeping, and maintenance.
- Is the operator familiar with the operation of the UV reactor?
- Determine if all the required forms are being completed, including DEP UV MOR, UVT meter, and intensity meter records.
- Ask follow-up questions regarding any missing data and data integrity. Is data ever deleted, changed or invalidated? If so, is it documented in the plant log. Do staff follow written procedures to ensure data integrity?
- How is % off-spec water determined and recorded?
- How often is the UV intensity duty sensor verified against the calibrated UV intensity reference sensor? Are there records documenting the verifications?
- How often is the UV intensity verification sensor calibrated? Are there records documenting the calibration?
- Verify operators conduct comparative UV intensity sampling.
- Request the operator to use a spectrophotometer to conduct comparative UV transmittance sampling and document the results. Verify grab sample results are within 10% of online analyzer results. Verify both results are within the control limit.
- Safety comment: Do not look at the UV light. Special UV protective eye wear should be used during UV intensity meter verifications.

UV Related Items for FPPE Report

- In addition to the normal FPPE activities and topics, prepare and include in the FPPE report the following annual trends:
    - 12 months of daily minimum UV log inactivation
    - 12 months of daily minimum UV intensity
    - 12 months of daily minimum UV transmittance

- Identify on the trend any plant goals, permit control limits, maintenance events, and performance deviation. Where applicable, provide some narrative that includes insight to any performance deviations to assist the reader with interpreting the data trends.

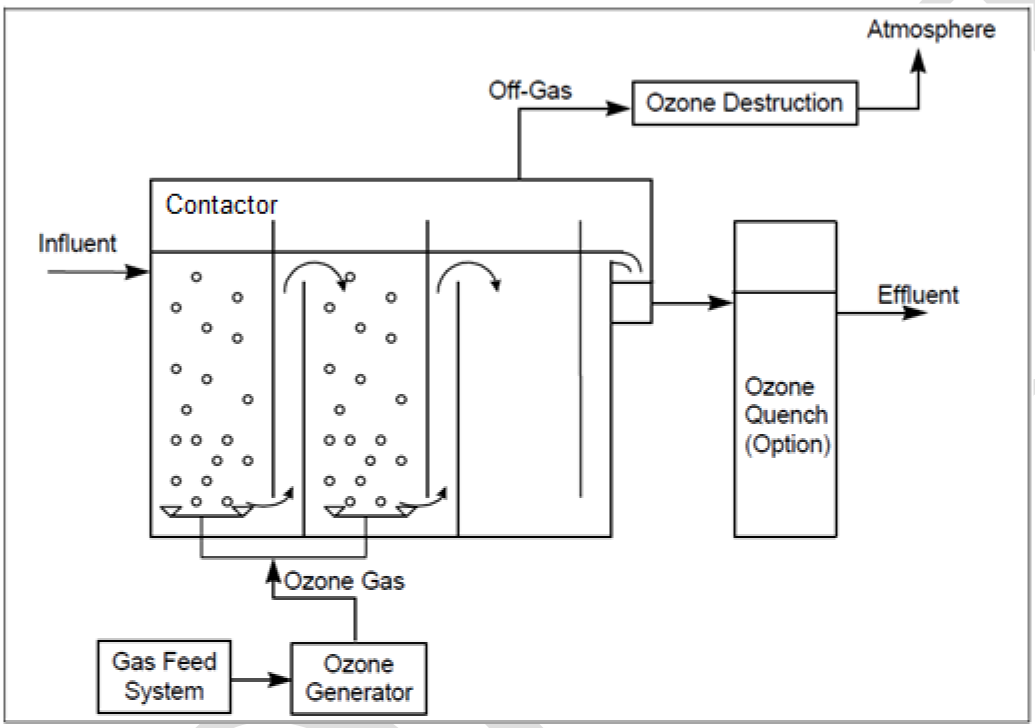
- All UV performance weaknesses should be documented in FPPE Comments section in priority order with other comments.

Attachment 5

Ozone Evaluation during FPPEs

Introduction to Ozone

Ozone is a strong oxidant that is colorless but has a strong odor (like fresh rain). It reacts rapidly but does not have a long-lasting residual (half-life of 20 minutes). Ozone will not all be consumed; it must be removed/destroyed. Ozone water treatment systems have four basic components:
1. a gas feed system, 2. an ozone generator, 3. an ozone contactor, and 4. an off-gas destruction system.



Simple Ozone Schematic Figure 3-4 from the EPA Alternative Disinfectants and Oxidants Guidance Manual (EPA 815-R-99-014).

There are many uses for ozone in drinking water systems.

- Oxidation of organic compounds to reduce DBP formation
- Oxidation of iron and manganese
- Oxidation of trace organic compounds, including other micropollutants compounds that produce taste and odor, phenolic compounds and some pesticides
- Lysing of algae to make biologically available and subsequently removed by biofiltration
- Biological stabilization (as pretreatment in conjunction with GAC). As ozone introduces large amounts of oxygen to the water, it promotes biological growth on the filter media. Biological activity develops to higher levels on GAC than on sand filters because of the higher specific surface area of GAC.
- Enhancing flocculation
- Disinfection (*Cryptosporidium*, *Giardia*, and Virus by permit only)

The key variables that determine ozone's effect in the oxidation of DBP precursors, prior to chlorination, include dose, transfer efficiency, pH, alkalinity, pressure, contact time and the nature of the organic material.

At low pH levels, precursor destruction is quite effective; at pH levels above 7.5, ozone is less effective for most humic substances, and sometimes increases the amount of chlorination byproduct precursors.

Advanced Preparation for Ozone Evaluation

Assemble all ozone related permits/documents/records

On-site Activities/Discussion Questions

- Is there an off-gas destruct unit on site and working? Destruct unit should be designed to reduce the concentration to 0.1 ppm of ozone by volume which is the current limit set by OSHA in an 8-hour exposure.

- Are there ambient ozone meters? Gas phase ozone detectors should be provided in spaces such as generator rooms where ozone gas may be and personnel are routinely present. An ozone detector is also needed on the outlet from the off-gas destruct unit to ensure the unit is working properly. These units should be interlocked with the ozone generator controls to shut down the ozone generation system should excess ozone be detected.

- Is ozone stripped from the water before moving to the next water process?

- Determine if flow is co-current or counter-current to the ozone injection (counter current is more effective; see Diagram 1 below).

- How is the ozone injected into the chamber? Best distribution is done with micro bubble diffusers.

- Is the chamber continuously stirred?

- What are the dimensions of the individual contact chamber? Contact chambers should be either continuously stirred or ideal plug flow configuration (1:4)

- Is bromate monitored? Primary EPA limit of 10ppb; entry point must be monitored

- Is chlorate monitored? This will form if ozone is still in the water when it gets chlorinated

- How is ozone monitored? Record the equipment used. Grab or online units?

- Are the ozone units verified for accuracy? Indigo Trisulfonate Method (4500-03B)

- Ozone analyzer location. Should be as close to the sample tap as possible (sample degrades quickly)

- How many sample taps are available for each chamber? Should have at least 10 grab locations per chamber

- What is the sample tap configuration? Sample taps should be near the internal wall and rotated away from the bubble flow.

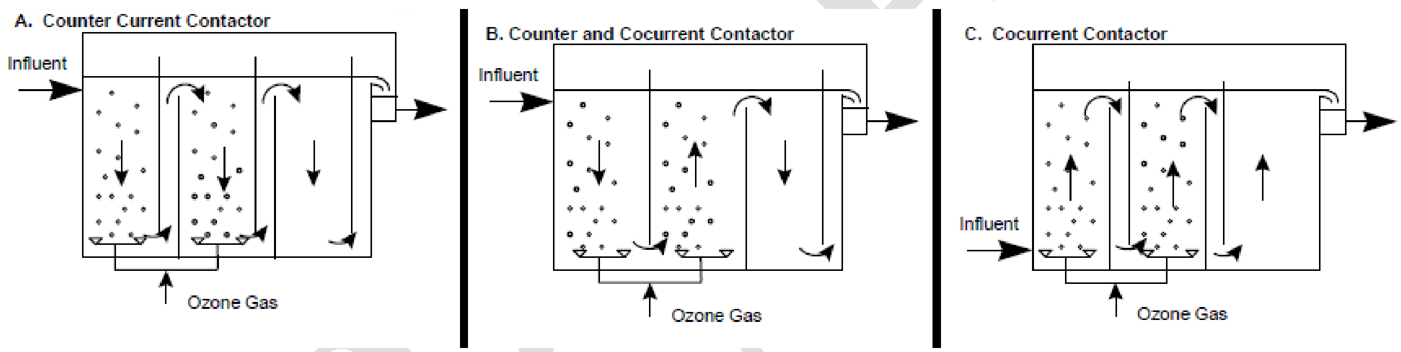
- How are grab samples used? Horizontal sample results should be within 25% of each other and then averaged. Each horizontal average value should then be used to average the entire basin. If a tank has zero residual in 50% of a chamber, tracer study calculations cannot be used to determine a disinfection level.

- Is the ozone sampling equipment calibrated/verified? Method 334 does not apply. Indigo Trisulfonate Method (4500-03B) does apply.

- Was a tracer study done? Tracer study data is not equivalent to hydraulic detention time. Tracer study must include the entire segment (all ozone chambers) because ozone tracers will not be linear and therefore cannot be added individually.

- Is ozone used for disinfection credit (by permit only)? If so, then it's critical that the system is in compliance with all permit special conditions.

Diagram 1. Ozone Flow Options



EPA calculator use if ozone is used for disinfection (by permit only)

Systems using ozone as a disinfectant with certain configurations may not be able to use this spreadsheet. Ozone systems with co-current or counter-current flow in the first (or only) chamber typically receive a credit of 0.50 log *Giardia* inactivation for the first chamber if the effluent ozone concentration is greater than 0.3 mg/L. These systems also typically receive a credit of 1.0 log virus inactivation for the first chamber if the effluent ozone concentration is greater than 0.1 mg/L. However, this spreadsheet does not address ozone system configurations and does not use this method for calculating log inactivation. For more information on calculating log inactivation for systems using ozone, refer to Example D-3 in Appendix D of the *LT1ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual* (EPA 816-R-03-004, 2003).