



# *US Filter*

## **EPA Membrane Filtration Guidance Manual**

### **Overview and Technical challenges**

# Outline

The manual is a 321 page draft document first published in June 2003. The manual's conception was a combined effort of membrane regulators, manufacturers, and end users. We will try to answer the following questions in this presentation.

- What is the purpose of the manual?
- What does the manual cover?
- How do we achieve the goals and meet the challenges outlined in the manual?

# **Guidance Manual for Membrane Filtration is first EPA recognition of MF and UF**

- MF and UF membranes finally recognized by EPA as a unit process for water treatment
- Expected that use of this guidance manual will extend beyond LT2 rule implementation
- Key features
  - Product specific testing to demonstrate microbial removal capability
  - Defined procedures for direct integrity testing
  - Allows for log removal credit up to the lower of challenge test result

# **MFGM Introduction Section**

- **This section summarizes the applicable regulations regarding membrane treatment and its goals.**
  - **SWTR & IESWTR**
  - **LT1 & LT2 regulations**
  - **DBP rules**
- **These rules set the guidelines and requirements for the membrane plants while the MFGM attempts to explain the why's and how's for getting it done.**

# **MFGM Membrane Filtration Overview**

- **This section details the differences between the many types of membrane treatment**
  - **Microfiltration**
  - **Ultrafiltration**
  - **Nanofiltration**
  - **Reverse Osmosis**
  - **Membrane Cartridge Filtration (MCF)**
  - **Electrodialysis and Electrodialysis Reversal (ED & EDR)**
- **This section also describes materials of membrane construction and the basics of how different membrane systems operate.**

# MFGM Challenge Testing

- This section describes the purpose and methods of challenge testing.
  - The purpose is to establish a log reduction value (LRV)
  - The test is designed to be product specific – not site specific
  - All details of the testing procedure are detailed including
    - Testing requirements
    - Modules to use
    - Target or surrogate organisms to use
    - Sampling procedures
    - Analysis of results
    - What to do after the test

# MFGM Direct Integrity Testing

- This section discusses the use of direct integrity testing as it pertains to the membrane modules and overall system.
  - Test Resolution
    - Pressure Based Tests
    - Marker Based Tests
  - Test Sensitivity
    - Pressure Based Tests
    - Marker Based Test
  - Test Frequency
  - Establishing Control Limits

# MFGM Direct Integrity Testing

- **Test Methods**
  - Pressure Decay Test – PDT
  - Vacuum Decay Test – VDT
  - Diffusive Airflow Test – DAF
  - Water Displacement Testing
  - Marker Based Testing
- **Diagnostic Testing**
  - Visual testing
  - Bubble Testing
  - Sonic Testing
  - Conductivity Profiling
  - Single Module Testing
- **Data Collection and Reporting**

# **MFGM Continuous Indirect Integrity Monitoring**

- **This section discusses the use of indirect integrity testing as it pertains to the membrane modules and overall system.**
  - **Turbidity Monitoring**
    - **Methods**
    - **Control Limits**
    - **Advantages and Limitations**
  - **Particle Counting and Monitoring**
    - **Methods**
    - **Control Limits**
    - **Advantages and Limitations**
  - **Other Methods and Data Collection**

# **MFGM Pilot Testing**

- **This section discusses the implementation of a pilot test and its use as a predictor of full scale performance.**
  - **Planning**
  - **Objectives**
  - **Testing & Monitoring**

# MFGM Implementation Considerations and Initial Start-Up

- This section discusses the use of direct integrity testing as it pertains to the membrane modules and overall system.
  - Operational Unit Processes
    - Backwashing
    - CIPs
    - Integrity testing
  - System Design Considerations
    - Flux
    - Water Quality
    - Temperature
  - Residuals Treatment & Disposal
    - Backwash residuals
    - CIP residuals
    - Concentrate
  - Details of how to start a system and commission it.

# So What is the Goal and What is the Challenge?

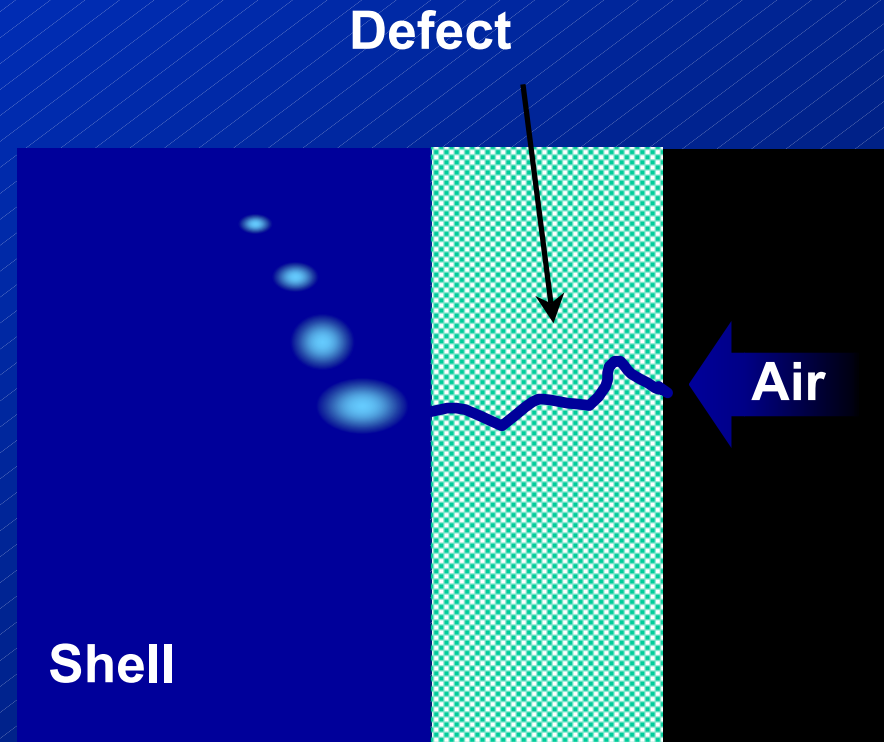
- The Goal is to have a water plant with safe reliable high quality drinking water being produced.
- The Challenge is build and maintain the plant in a way so that it can produce that high quality water.
- The next Challenge is to be able to prove the system is working.

# Product Specific Testing

- Every state could, in principle, require a different testing protocol
- Challenge testing of one or more modules with *Cryptosporidium* or a surrogate particle
- Expected that challenge testing with a reputable consulting engineer or independent test house will be widely accepted
- Some possibility that states will accept in-house challenge testing by manufacturers with reliable quality management systems (Memcor is certified to ISO 9001 at our module production site)

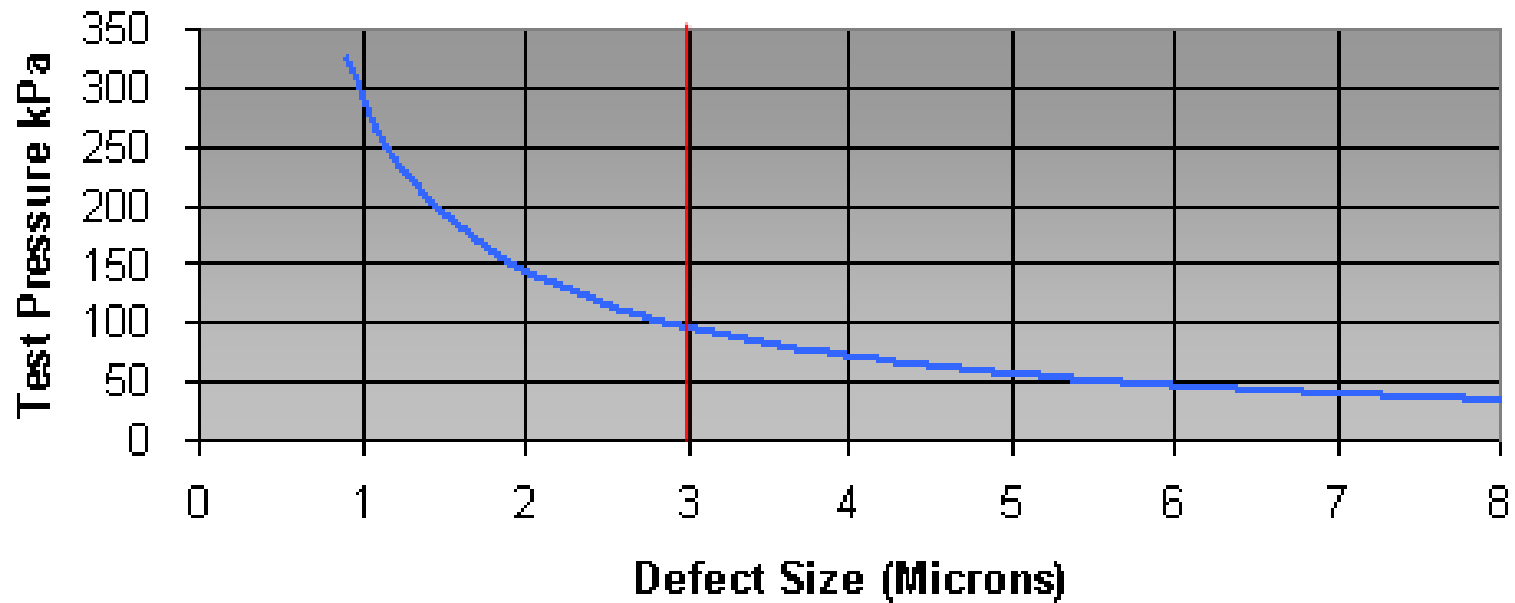
# Direct Integrity Test

- Must sample defects as small as 3 microns. Memcor achieves this requirement with certainty by adopting with a conservative 14.5 psi test pressure.
- Test sensitivity depends on instrumentation response and physical arrangement. Memcor achieves 4.5 log routinely, can go to 5 log with PDT, 5.5 log with DAF
- Guidance manual provides example calculations for determining control limits.



# Effects of Integrity Test Pressure

Integrity Test Pressure vs Minimum Defect Size



# Long Term 2 Enhanced Surface Water Treatment Rule focuses on Cryptosporidium

- Particle removal requirements are tied to Crypto risk
- Four risk “bins” based on crypto concentration found in monitoring
- Plants complying with LT1 ESWTR are assumed to achieve LRV 3
- Additional particle removal required in each bin:
  - Bin 1  $0 < C < 0.075/L$  No additional treatment
  - Bin 2  $0.075/L < C < 1.0/L$  Additional 1 log treatment
  - Bin 3  $1.0/L < C < 3.0/L$  Additional 2 log treatment
  - Bin 4  $C > 3.0/L$  Additional 2.5 log treatment
- Assume plants complying with IESWTR achieve 3 log removal on average

# How will additional log removal be achieved

- Most surface water treatment systems will land in Bin 1 and will not require additional treatment
- Membrane filtration can readily provide 4 log removal for new systems in Bin 2
- Theoretical limit for membrane filtration is LRV 6, but impractical to maintain membrane system above LRV 4.5
- Pre-sedimentation, UV and/or ozone are likely to provide additional log removal credits required for new systems in Bin 3 and Bin 4
- Existing systems in Bin 3 and 4 will likely add either UV or membranes to achieve additional LRV

# LT2ESWTR Toolbox

- Toolbox is the set of technologies approved by EPA for achieving required additional log removals.
- Pre-sedimentation basin with 0.5 log credit with continuous coagulation.
- Combined filter performance..... 0.5 log credit for combined filter effluent turbidity  $\leq$  0.15 NTU
- Roughing filters..... No presumptive credit proposed. .
- Second stage filtration..... 0.5 log credit for second separate filtration stage;
- Membranes..... Log credit equivalent to challenge test for device if supported by integrity testing.
- Bag filters..... 1 log credit if 2 log removal efficiency in challenge test.
- Cartridge filters..... 2 log credit if 3 log removal efficiency in challenge test.
- Chlorine dioxide..... Log credit based on demonstration of log inactivation
- Ozone..... Log credit based on demonstration of log inactivation
- UV..... Log credit based on UV dose table
- Individual filter performance..... 1.0 log credit for turbidity  $<$  0.1 NTU from individual filters
- Demonstration of performance..... Credit based on demonstration to the State

# Summary

The guidance manual is there to help you both determine the type of membrane needed as well what performance to expect from them.

Remember the goal is great water, the challenge is producing it with reliability.

- Look at what type of treatment you need
- Pick the best technology that accomplishes the treatment goal
- Look at the LRV values required
- Make sure your challenge test and Integrity test meet the LRV requirements
- Look to LT2 Tool Box for more help