

## Operational Guideline for Manitoba Water Suppliers

### Monitoring Membranes for Compliance in Turbidity and Protozoa Log Removal

The Drinking Water Quality Standards Regulation (MR 41/2007) requires all surface and groundwater under the direct influence of surface water (GUDI) sourced systems to provide a minimum removal and inactivation of 3-log *Cryptosporidium* and *Giardia* and 4-log viruses, and specifies the physical standard (turbidity) for water treatment plants employing membrane filtration systems.

This document provides information on monitoring membrane filtration for compliance with turbidity and protozoa removal requirements.

Membranes are very effective at removing turbidity when the membrane fibers are intact. Nanofiltration (NF) and reverse osmosis (RO) processes are pressure driven processes designed to remove solutes in water; they are not typically designed for high particle removal without some form of pre-treatment. Microfiltration (MF) and ultrafiltration (UF) processes are capable of reducing turbidity to below 0.1 NTU; and because the membrane integrity can be measured directly, these are the membrane processes regulated the Office of Drinking Water for 3-log compliance purposes.

#### Definitions used in this document:

**“Reading”** means the turbidity value collected and recorded using the shortest/smallest time increment of the instrument (ex. readings every 1 or 3 seconds) while the membrane is in operation.

**“Measurement”** means the average of Readings that are calculated, recorded and reported in 5-minute intervals while the membrane is in operation. This Measurement is used for compliance purposes.

**“Membrane Train, Rack or Skid”** means a group of membrane modules that share common valving that allows the unit to be isolated from the rest of the system for the purpose of integrity testing or maintenance.

**“Direct Integrity Test or Membrane Integrity Test”** (DIT, MIT) is a physical test applied to a Membrane Train in order to identify integrity breaches. MIT parameters must include a minimum 5 minute (300s) pressure decay test.

**Turbidity Standard** Less than or equal to 0.1 NTU in 99% of the Measurements in a month of the filtrate from each operating ultra/microfiltration Membrane Train and not to exceed 0.3 NTU for any Measurement.

In order to conduct MITs, the Membrane Train must be taken off line and a MIT must be performed. A failed MIT indicates that an integrity breach may have occurred sometime between the most recent test in which the integrity was verified and the failed test. Continuous monitoring of turbidity provides real-time information on membrane integrity. MIT and turbidity monitoring are complementary; both are critical elements of a comprehensive compliance program.

#### *Understanding the Turbidity Standard:*

- "normal operating standard" is less than or equal to 0.1 NTU in 99% of the Measurements in a month
- “HBTL” are health based treatment limits that have been established for the normal operating standard to help ensure that systems are meeting the minimum levels of pathogen removal (log removal credits) and allows water supplies to establish operational procedures that are effective for each Membrane Train. HBTLs are represented as a percentage of time (ex: 99%) the filter effluent must comply with the normal operating standard. The HBTL allows water supplies some flexibility for addressing uncertainty in turbidity Measurements due to instrumentation issues (ex: air bubbles), while at the same time recognizing Measurements over 0.1 NTU for more than 15 minutes (three consecutive Measurements) may indicate an integrity breach.
- "not-to-exceed standard" is not to exceed 0.3 NTU for any Measurement

**Microbial Standard**

- Water systems shall have in place and maintain in effective working order, filtration equipment and controls designed to provide minimum reduction or inactivation of 99.9% (3-log) of Cryptosporidium oocysts and 99.9% (3-log) of Giardia lamblia cysts; and
- A minimum log removal value of 3.00 for Cryptosporidium and Giardia following a daily MIT.

**Routine Monitoring Requirements**

- Continuous turbidity monitoring of the filtrate from each operating ultra/microfiltration Membrane Train.
- Equipment must be capable of monitoring turbidity Readings to report an average Measurement at a maximum of 5-minute intervals in the filtrate from each operating ultra/microfiltration Membrane Train.
- Confirmatory turbidity grab samples are taken daily at each turbidity analyzer sampling location(s). The analyzer Reading must be recorded at the same time as the confirmatory result in order to compare results.
- Turbidity is to be measured and recorded only when the filter train is operating.
- Filter profiles created by SCADA provide a visual representation of individual filter performance. A filter profile will show continuous turbidity Measurements versus time for an entire filter run. Filter profiles may also include individual Readings. A filter profile must accompany the monthly turbidity report forms whenever turbidity has exceeded a standard.
- A daily MIT reporting of the LRV for each Membrane Train in operation for that day.

**Alarm set points:**

- Where turbidity exceeds 0.1 NTU for three (3) consecutive Measurements (15 minutes), the alarm immediately triggers an investigation, which may or may not include MIT
- Where turbidity exceeds 0.3 NTU for any Measurement, the alarm automatically triggers a shutdown of the Membrane Train.

The Office of Drinking Water recommends alarm set point for shutdown be set at 0.29 NTU (0.24 if program rounds up to 0.3 NTU) to avoid non-compliance Measurements.

**Routine Reporting Requirements**

- **TURBIDITY:** The Water System Operator shall record the Daily Average (average of Measurements) and the Daily Maximum (maximum Measurement) on the monthly report form. Include the number of Measurements and the number of Measurements over the standard each day for each operating filter.
- **LOG REMOVAL VALUE (LRV):** The Water System Operator shall record the result(s) of the daily MIT for each operating filter. The manufacturer’s LRV determined during challenge testing must be recorded on the form. Example of the Monthly Turbidity Report Form attached.
- The Water System Operator shall keep one copy of all monthly report forms and forward the original copy including filter profiles where applicable, to the regional Drinking Water Officer within seven days after the end of each calendar month
- The Water System Operator shall retain report forms for a minimum of 24 months

**Emergency Reporting Requirements**

- Water System Operators must immediately notify the Office of Drinking Water of any condition that may affect the ability of the water system to produce or deliver safe drinking water including but not limited to treatment upsets or bypass conditions, contamination of the source water or treated water, a disinfection system failure, or a distribution system failure.

Emergency reporting requirements specific to Membrane Filtration:

Where a Membrane Train passes an MIT, and cannot be removed from service, and

- turbidity Measurement exceeds 0.3 NTU;
- turbidity exceeds 0.1 NTU for more than 3 Measurements (15 minutes); or
- turbidity exceeds 0.1 NTU in greater than 1% of the time prior to the month end; or
- LRV is less than 3.0 following a MIT

Where a Membrane Train is

- unable to meet the continuous monitoring requirement (analyzer failure);
- unable to correct a failed MIT and the Membrane Train is required to operate to ensure capacity; or
- Unable to conduct a daily MIT

Consideration should be given to discontinue blending MF/UF filtrate around the second stage membrane process (NF/RO) following a turbidity exceedance (> 0.1 NTU for more than 3 consecutive Measurements (15 minutes) or turbidity exceeds 0.1 NTU > 1% of the time prior to the month end) or LRV value < 3.0 following a MIT.

For purposes of issuing a Boil Water Advisory due to any condition, including those listed above, consideration will be given to daily LRV's and continuous turbidity monitoring and reporting following the second stage (NF/RO) process or entering the distribution system.

### Trouble Shooting

Some simple steps that operators can take to avoid non-compliant turbidity measurements:

- Clean and calibrate analyzers when the membrane filtration train is off line
- Minimize the length of sample lines to continuous monitoring equipment
- Set the sample flow within the instrument specifications
- Discuss any turbidity spikes during start-up, following backwash, clean in place (CIP) or MIT with your regional Drinking Water Officer
- Consider installing laser turbidimeters which are more sensitive/accurate at very low turbidity levels

### Office of Drinking Water

Regional [Drinking Water Officers](#) are available for operational and monitoring advice and technical assistance.

After hours, please call the Environmental Emergency Response line at 204-944-4888 and ask for the on-call drinking water officer

For more information related to Manitoba's drinking water and how it is regulated visit:

[www.manitoba.ca/drinkingwater](http://www.manitoba.ca/drinkingwater)

**MONTHLY TURBIDITY REPORT FORM**  
(On-line Instruments)

WATER SYSTEM: \_\_\_\_\_ WATER SYSTEM CODE: \_\_\_\_\_  
 MONTH: Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec YEAR: 20\_\_\_\_\_  
 OPERATOR-IN-CHARGE: \_\_\_\_\_  
 Filter: \_\_\_\_\_ Monthly Chemical Clean date: \_\_\_\_\_ Challenged Tested Minimum Log Removal Value: \_\_\_\_\_

Date	Time	Operator Initials	TURBIDITY, NTU											Integrity Test Results		
			Raw	Filter Train 1				Entering Reservoir		Leaving Reservoir		LRV				
				Permeate Confirmatory *Portable	Permeate Confirmatory *Display	Avg.	Max.	# of Measurements		Avg.	Max.		Avg.		Max.	
1																
...																
31																
<b>Monthly Totals</b>										<b>Total</b>	<b>%</b>					

Submitted by (Print): \_\_\_\_\_ Signature: \_\_\_\_\_

**DISTRIBUTION:**  
 FORWARD THE ORIGINAL TO YOUR DRINKING WATER OFFICER  
 RETAIN A COPY FOR YOUR RECORDS

PLEASE CONTACT YOUR DRINKING WATER OFFICER WITH ANY COMMENTS, QUESTIONS OR CONCERNS

**Required Fields:**  
**Header including Water System Name, Code, Month, Year, Operator in Charge**  
**Filter number**  
**Monthly Chemical Clean date:** Include all dates if cleaned more than once per month  
**Challenge Tested Minimum Log Removal Value:** The log credit value that was awarded to the filter in challenge testing - should be equal to or greater than 4  
 Date: Day of the Month  
 Time: Time operator took confirmatory Readings  
 Operator Initials: Operator who took confirmatory Readings  
 Raw: take and record portable measurement or maximum daily where monitoring online  
 Confirmatory Portable: take and record portable measurement  
 Confirmatory Display: record on-line display Reading at the same time of sampling  
**Filter 1: information within the highlighted area must be captured for each operating filter - use additional sheets for each filter train**  
 Avg.: Average daily Measurement  
 Max.: Maximum daily Measurement  
 Integrity Test Results: Report the actual Log Removal Value calculated  
**# of Measurements: Measurements recorded specific to the operating filter for that day**  
 Total: Total number of Measurements recorded  
 > STND: Number of Measurements that were above the normal operating standard  
**Compliance: Total number of Measurements divided by number of Measurements > STND x 100 = %**  
 Signature Block

**Operations - Optional**  
 Entering Reservoir: Measurement of the combined effluent  
 Avg.: Average daily Reading  
 Max.: Maximum daily Reading  
 adjust if portable unit is used

Leaving Reservoir: Measurement of the entering the distribution - good for determining when the reservoir requires cleaning  
 Avg.: Average daily reading  
 Max.: Maximum daily reading  
 adjust if portable unit is used