

Membrane Filtration & the LT2ESWTR

By Brent Alspach

Under the federal Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), membrane filtration is designated as one of the “toolbox technologies” that may be used to achieve Cryptosporidium reduction. As a result, the Membrane Filtration Guidance Manual (MFGM) has been developed to assist the water treatment community with the implementation of membrane filtration for rule compliance. Because the MFGM describes the use of this rapidly expanding technology within the context of the first federal (i.e., nationwide) regulatory framework that specifically addresses membrane filtration, the document has generated significant interest in the water treatment industry.

It is important to understand that the LT2ESWTR does not regulate all membrane filtration installations, but rather only those systems that are used explicitly for compliance with the *Cryptosporidium* removal requirements of the rule. It is anticipated, however, that many state primacy agencies will opt to voluntarily adopt some or all of LT2ESWTR framework in a more comprehensive context governing most all applications of membrane filtration for drinking water treatment. Consequently, the MFGM has been carefully developed to easily lend itself to membrane treatment applications outside the mandate of the LT2ESWTR, including *Giardia*, viruses and other pathogens.

The intent of this article is to provide a short summary of the regulatory framework for membrane filtration under the LT2ESWTR, highlighting the major requirements for compliance.

The LT2ESWTR Framework

The LT2ESWTR is the first federal water treatment regulation that addresses membrane filtration as a distinct technology. Because it is designated as one of the many toolbox options that utilities can use to comply with the *Cryptosporidium* treatment requirements of the rule, the U.S. Environmental Protection Agency (EPA) developed a regulatory framework for membrane filtration designed to assess the *Cryptosporidium* removal credit that could be awarded and subsequently to verify the ability to achieve that awarded credit on

an ongoing basis during operation.

If baseline monitoring demonstrates that specific source water is vulnerable to *Cryptosporidium* contamination, any public water system utilizing that source and electing to use membrane filtration to comply with the associated *Cryptosporidium* removal requirements of the LT2ESWTR is subject to the membrane-specific regulatory framework established under the rule. In order to be eligible to receive *Cryptosporidium* removal credit, the rule prescribes three basic criteria for membrane filtration systems:

1. The process must comply with the definition of membrane filtration as stipulated by the rule.

Under the LT2ESWTR, membrane filtration is defined as a pressure- or vacuum-driven separation process in which particulate matter larger than 1 μm 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. The definition is designed to include not only MF and UF, but also NF and RO processes as well which can theoretically (but in general, not practically) be utilized to filter *Cryptosporidium*.

2. The removal efficiency of a membrane filtration process must be established through a product-specific challenge test and direct integrity testing.

The LT2ESWTR does not prescribe a specific *Cryptosporidium* removal credit for

membrane filtration, but instead establishes removal credit based on system performance as determined by challenge testing and verified by direct integrity testing. Thus, the maximum removal credit that a membrane filtration process may receive is the lower value of either:

- The removal efficiency demonstrated during challenge testing; or
- The maximum log removal value (LRV) that can be verified by the direct integrity test used to monitor the membrane filtration process

Challenge testing is intended to be a one-time, product-specific test to establish the maximum *Cryptosporidium* log removal credit that the product is eligible to receive as applied for LT2ESWTR compliance (subject to state approval). Note that the LT2ESWTR does not require site-specific pilot testing.

3. The membrane filtration system must undergo periodic direct integrity testing and continuous indirect integrity monitoring during operation.

The LT2ESWTR requires that the *Cryptosporidium* log removal credit awarded to the membrane filtration process be verified on an ongoing basis during operation. This verification is accomplished by conducting daily direct integrity testing,

Overview of the regulatory framework for membrane filtration under the LT2ESWTR

defined as physical testing applied directly to the pathogen barrier (e.g., a pressure decay test) associated with a membrane unit (e.g., a rack, a skid, etc.) in order to identify and isolate integrity breaches. Criteria for applying a direct integrity test under the LT2ESWTR include requirements for both the sensitivity and resolution of the test. Sensitivity is defined as the maximum LRV that can be reliably verified by the direct integrity test associated with a given membrane filtration system. The LRV for the test must be equal to or greater than the *Cryptosporidium* removal credit awarded to the system in order to achieve compliance with the LT2ESWTR. If the results of the direct integrity test do not demonstrate the required LRV (i.e., that commensurate with the awarded *Cryptosporidium* removal credit), the affected membrane unit must be immediately taken out of service for further evaluation and repair.

Although direct integrity testing represents the most sensitive means of detecting integrity breaches, these tests cannot be conducted on a continuous basis while the membrane filtration system is in operation. Thus, direct integrity testing is implemented at regular intervals and complemented by indirect integrity monitoring (i.e., filtrate turbidity monitoring), which is generally much less sensitive but can be conducted continuously during filtration. This continuous indirect integrity monitoring allows for a coarser assessment of membrane integrity between periodic applications of a more sensitive direct integrity test.

The LT2ESWTR requires filtrate turbidity monitoring (for each membrane unit) as the default method for continuous indirect integrity monitoring. However, alternative methods such as particle counting, particle monitoring, or others may also be approved at the discretion of the state primacy agency. Independent of the method used, "continuous" monitoring is defined as one reading at least every 15 minutes. The LT2ESWTR specifies a performance benchmark (i.e., a control limit) of 0.15 NTU for turbidity monitoring, such that if the filtrate turbidity associated with any membrane unit exceeds 0.15 NTU for a period greater than 15 minutes (i.e., two consecutive 15-minute readings higher than 0.15 NTU), that unit must immediately undergo direct integrity testing. Although control limits for alternative methods are determined at the discretion of the state primacy agency, two consecutive 15-minute readings exceeding the state-approved control limit for any alternate method would likewise trigger immediate direct integrity testing for the associated membrane unit.

Additional Information

Detailed requirements for challenge testing, direct integrity testing and continuous indirect integrity monitoring, as well as guidance on the implementation of these requirements, are provided in the

EPA *Membrane Filtration Guidance Manual*. The document is available for download from the EPA website at www.epa.gov/safewater/disinfection/lt2/compliance.html

The language of the LT2ESWTR, as well as background information on the rule, is published in the Federal Register (Vol. 71, No. 3 – Jan. 5, 2006).

Additional information may also be obtained by contacting the author. wqpp

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