

Most direct integrity tests available at the time of this proposal must be applied periodically since it is necessary to take the membrane unit out of service to conduct the test. Today's proposal establishes the minimum frequency for performing a direct integrity test at once per 24 hours. Currently, there is no standard frequency for direct integrity testing that has been adopted by all States and membrane treatment facilities. In a recent survey, the required frequency of integrity testing was found to vary from once every four hours to once per week; however, the most common frequency for conducting a direct integrity test was once every 24 hours (USEPA 2001h). Specifically, 10 out of 14 States that require periodic direct integrity testing specify a frequency of once every 24 hours. Furthermore, many membrane manufacturers of systems with automated integrity test systems set up the membrane units to automatically perform a direct integrity test once per 24 hours. EPA has concluded that the 24 hour direct integrity test frequency ensures that removal efficiency is verified on a routine basis without resulting in excessive system downtime.

Since most direct integrity tests are applied periodically, it is necessary to implement some level of continuous monitoring to assess process performance between direct integrity test events. In the absence of a continuous direct integrity test, continuous indirect integrity monitoring is required. Although it has been shown that commonly used indirect integrity monitoring methods lack the sensitivity to detect small integrity breaches that are of concern (Adham *et al.* 1995), they can detect large breaches and provide some assurance that a major failure has not occurred between direct integrity test events. Turbidity monitoring is proposed as the method of indirect integrity monitoring unless the State approves an alternate approach. Available data indicate that an integral membrane filtration process can consistently produce water with a turbidity less than 0.10 NTU, regardless of the feedwater quality. Consequently, EPA is proposing that exceedance of a filtrate turbidity value of 0.15 NTU triggers direct integrity testing to verify and isolate the integrity breach.

c. *Request for comment.* EPA requests comment on the following issues:

- EPA is proposing to include membrane cartridge filters that can be direct integrity tested under the definition of a membrane filtration process since one of the key differences between membrane filtration processes and bag and cartridge filters, within the

context of this regulation, is the applicability of direct integrity test methods to the filtration process. EPA requests comment on the inclusion of membrane cartridge filters that can be direct integrity tested under the definition of a membrane filtration process in this rule.

- The applicability of the proposed *Cryptosporidium* removal credits and performance criteria to *Giardia lamblia*.

- Appropriate surrogates, or the characteristics of appropriate surrogates, for use in challenge testing. EPA requests data or information demonstrating the correlation between removal of a proposed surrogate and removal of *Cryptosporidium* oocysts.

- The use of a non-destructive performance test and associated quality control release values for demonstrating the *Cryptosporidium* removal capability of membrane modules that are not directly challenge tested.

- The appropriateness of the minimum direct integrity test frequency of once per 24 hours.

- The proposed minimum reporting frequency for direct integrity testing results above the control limit and indirect integrity monitoring results that trigger direct integrity monitoring.

12. Bag and Cartridge Filtration

a. *What is EPA proposing today?* EPA is proposing criteria for awarding *Cryptosporidium* removal credit of 1 log for bag filtration processes and 2 log for cartridge filtration processes. To receive removal credit the process must: (1) Meet the basic definition of a bag or cartridge filter and (2) have removal efficiency established through challenge testing.

Definition of a Bag or Cartridge Filter

For the purpose of this rule, bag and cartridge filters are defined as pressure driven separation processes that remove particulate matter larger than 1 μ m using an engineered porous filtration media through either surface or depth filtration.

The distinction between bag filters and cartridge filters is based on the type of filtration media used and the manner in which the devices are constructed. Bag filters are typically constructed of a non-rigid, fabric filtration media housed in a pressure vessel in which the direction of flow is from the inside of the bag to outside. Cartridge filters are typically constructed as rigid or semi-rigid, self-supporting filter elements housed in pressure vessels in which flow is from the outside of the cartridge to the inside.

Although all filters classified as cartridge filters share similarities with

respect to their construction, there are significant differences among the various commercial cartridge filtration devices. From a public health perspective, an important distinction among these filters is the ability to directly test the integrity of the filtration system in order to verify that there are no leaks that could result in contamination of the filtrate. Any membrane cartridge filtration device that can be direct integrity tested according to the criteria specified in section IV.C.11.a is eligible for removal credit as a membrane, subject to the criteria specified in that section. Section IV.C.12 applies to all bag filters, as well as to cartridge filters which cannot be direct integrity tested.

Challenge Testing

In order to receive 1 log removal credit, a bag filter must have a demonstrated removal efficiency of 2 log or greater for *Cryptosporidium*. Similarly, to receive 2 log removal credit, a cartridge filter must have a demonstrated removal efficiency of 3 log or greater for *Cryptosporidium*. The 1 log factor of safety is applied to the removal credit awarded to these filtration devices based on two primary considerations. First, the removal efficiency of some bag and cartridge filters has been observed to vary by more than 1 log over the course of operation (Li *et al.* 1997, NSF 2001a, NSF 2001b). Second, bag and cartridge filters are not routinely direct integrity tested during operation in the field; hence, there is no means of verifying the removal efficiency of filtration units during routine use. Based on these considerations, a conservative approach to awarding removal credit based on challenge test results is warranted.

Removal efficiency must be demonstrated through a challenge test conducted on the bag or cartridge filter proposed for use in full-scale drinking water treatment facilities for removal of *Cryptosporidium*. Challenge testing is required for specific products and is not intended to be site specific. At the discretion of the State, data from challenge studies conducted prior to promulgation of this regulation may be considered in lieu of additional testing. However, the prior testing must have been conducted in a manner that demonstrates a removal efficiency for *Cryptosporidium* commensurate with the treatment credit awarded to the process. Guidance on conducting challenge studies to demonstrate the *Cryptosporidium* removal efficiency of filtration units is presented in the Membrane Filtration Guidance Manual (USEPA 2003e). Challenge testing must