An Overview of the Proposed Long Term 2 Enhanced Surface Water Treatment Rule and Stage 2 Disinfectants and Disinfection Byproducts Rule

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USEPA has recently proposed additional regulations to control microbial pathogens and disinfection byproducts in drinking water. These are the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (1) and Stage 2 Disinfectants and Disinfection Byproducts Rule (S2DBPR) (2). The rationale and elements of these rules are summarized briefly to highlight significant components. The details of these rules are extremely complex; those wishing a fuller understanding must consult the proposed regulatory language.

BACKGROUND TO THE REGULATORY PROPOSALS

Following promulgation of the Surface Water Treatment Rule (SWTR) (3) in 1989, which mandated control of waterborne microbial pathogens by a combination of filtration and disinfection, interest turned to control of the chemical byproducts resulting from disinfection treatment. It was appreciated immediately that the known health benefits from disinfection would have to be maintained and carefully balanced against protections from possible byproduct-derived health impacts. In order to involve the entire drinking water community in these decisions, USEPA conducted a negotiated rule-making process to discuss the issues and determine appropriate approaches to controlling both pathogens and these byproducts simultaneously.

This resulted in a series of National Primary Drinking Water Regulations (NPDWRs) and information-gathering activities being brought forward. The Interim Enhanced Surface Water Treatment Rule (IESWTR) (4) and Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) (5) were designed to prevent utility backsliding on disinfection and to upgrade physical removal of pathogens, especially the protozoan, Cryptosporidium. This organism had been singled out for particular attention due to a large waterborne disease outbreak in Milwaukee that had occurred during this time frame. It was also seen as more difficult to control than *Giardia*, the benchmark organism of the SWTR.

The Stage 1 Disinfectants and Disinfection Byproducts Rule (S1DBPR) (6) sought to control a number of halogenated organic compounds and other byproducts that had been associated with possible adverse health consequences. Maximum contaminant levels (MCLs) for total trihalomethanes (TTHM), five haloacetic acids (HAA5), bromate, and chlorite were established. Requirements to control byproduct precursors also were established. An Information Collection Rule (ICR) (7) was issued to fill in large occurrence and operational information data gaps. The recognition of these gaps led to an agreement to revisit open issues when adequate data were available. Amendments to the Safe Drinking Water Act in 1996 codified this agreement and required specific regulations and time lines.

Because a suitable disinfectant for *Cryptosporidium* was not available at the time of the initial negotiated rulemaking, enhancements to SWTR disinfection criteria could not be brought forward. Free chlorine and chloramines are ineffective inactivation agents for Cryptosporidium, and ozone and chlorine dioxide were not then seen as suitable for the wide range of necessary applications. In addition, both ozone and chlorine dioxide can produce adverse byproducts. In the intervening time, however, the work of Jennifer Clancy and others demonstrated that ultraviolet (UV) light effectively inactivated Crytosporidium with few downsides. While experience from large-scale drinking water applications in the U.S. was limited, the opportunities presented by UV were immediately utilized.

Additionally, early analytical methods for *Cryptosporidium* were too problematic to allow adequate quantification of this organism in source water. As a result, the IESWTR and LT1ESWTR continued the "one size fits all" SWTR approach of uniform filtration and disinfection treatment requirements. Water systems that used filtration treatment had to ensure 99% (2-logs) removal of Cryptosporidium, which was determined based on operational criteria. However, it was acknowledged that surface water sources varied markedly in their levels of microbial pathogen contamination and that proportional treatment was desirable. Improved *Cryptosporidium* analytical methods and data resulting from the ICR opened the possibility of this approach.

With respect to disinfection byproducts, it was recognized that the current compliance approach that averaged monitoring data across both time (running annual average of quarterly samples) and space (the entire distribution system) permitted situations where some customers could receive drinking water with levels above the byproduct MCLs for long periods of time. However, relatively little was known about the nature and causes of these byproduct "hot spots", nor how they could be controlled. Additionally, opportuni-

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ties to control byproducts by using alternative disinfectants required further study.

A second Microbial/Disinfection Byproducts Federal Advisory Committee subsequently examined results of the ICR and other new data. The Stage 2 M-DBP Agreement in Principle (8), developed in 1999 and 2000, laid out the components that would comprise two new NPDWRs, the LT2ESWTR and S2DBPR.

Among the principles was an explicit acknowledgement that UV disinfection was a keystone treatment technology underpinning the proposals. USEPA stated its belief that UV disinfection was "available and feasible". USEPA also had mandates to provide several technical documents to support adoption of UV disinfection

PROPOSED ELEMENTS OF THE LT2ESWTR

The general goal of the LT2ESWTR is to provide additional protection to the public from drinking water from sources with higher levels of Cryptosporidium. The regulatory elements include an initial assessment of source water levels of this pathogen, then additional treatment based on the analytical results. In addition, systems must determine current disinfection levels and cover all open finished water reservoirs.

Monitoring Requirements for Filtered Systems

As proposed, surface water systems that filter their water and serve 10,000 or more people will be required to monitor each of their source waters for Cryptosporidium, E. coli and turbidity monthly for two years. Either Method 1622 or 1623 may be used, using total oocyst count, unadjusted for recovery. Running annual averages for *Cryptosporidium* will be calculated. Systems will be given the option of monitoring semi-monthly or more often. If this is done, the mean average *Cryptosporidium* concentration of all samples may be calculated and used.

Surface water systems that filter their water and serve fewer than 10,000 people initially will monitor their sources for E. coli biweekly for one year. In this application, E. coli monitoring is being used as a less expensive surrogate for Cryptosporidium. If their results are above benchmark levels, they then must monitor for *Cryptosporidium* semi-monthly for an additional year. These benchmarks are mean E. coli levels of 10/100 mL for lake and reservoir sources, and 50/100 mL for flowing stream sources. If their results are below these benchmarks, no further monitoring is required. The mean average *Cryptosporidium* concentration of all samples will be calculated.

Any filtered system can avoid monitoring if they provide 99.9997% (5.5-logs) of total *Cryptosporidium* control.

Monitoring Requirements for Unfiltered Systems

Unfiltered surface water systems serving 10,000 or more people will be required to monitor each of their source waters for *Cryptosporidium* monthly for two years. E. coli and turbidity monitoring is not required.

Unfiltered surface water systems serving fewer than 10,000 people must monitor for *Cryptosporidium* semi-monthly for one year. These systems do not monitor for E. coli or turbidity.

Unfiltered systems can avoid monitoring if they provide 99.9% (3.0-logs) *Cryptosporidium* inactivation.

Bin Assignment and Treatment Requirements for Filtered Systems

Filtered systems will be placed into one of four possible "bins" based on monitoring results. Additional treatment will be based on bin classification and current filtration treatment. Systems with source water *Cryptosporidium* levels <0.075 oocysts/L fall into Bin 1 and have no additional treatment requirements.

Bin 2 is for *Cryptosporidium* levels between 0.075 and 1.0 oocysts/L. Systems with conventional, slow sand or diatomaceous earth filtration must provide an additional 90% (1.0-log) treatment. Systems that use direct filtration must provide an additional 97% (1.5-log) treatment. This difference is because conventional, slow sand and diatomaceous earth filtration currently are given 3.0-logs removal credit. Direct filtration is only given 2.5-logs credit. The overall treatment goal for this bin is 99.99% (4-logs) filtration and/or inactivation.

Bin 3 is for *Cryptosporidium* levels between 1.0 and 3.0 oocysts/L. It requires an additional 99% (2.0-logs) treatment for systems with conventional, slow sand or diatomaceous earth filtration, 99.7% (2.5-logs) for systems with direct filtration. Total treatment is to be 99.999% (5-logs).

Bin 4, for source waters with greater than 3.0 oocysts/L, requires an additional 99.7% (2.5-logs) treatment for conventional, slow sand or diatomaceous earth systems, 99.9% (3.0-logs) for direct filtration systems. Total treatment is to be 99.9997% (5.5-logs).

Treatment Requirements for Unfiltered Systems

All unfiltered systems must provide at least 99% (2-logs) *Cryptosporidium* inactivation, in addition to current 99.9% *Giardia* lamblia and 99.99% virus inactivation requirements. If source water levels of *Cryptosporidium* are above 0.01 oocysts/L, at least 99.9% (3-logs) inactivation is required. At least two disinfectants must be used. Each disinfectant must separately achieve the total inactivation required for *Cryptosporidium, Giardia lamblia*, or viruses.

Treatment "Toolbox"

Systems may use a number of treatment approaches in various combinations to meet additional requirements. This

"microbial toolbox" includes proactive peer review or validation; watershed pathogen control programs; use of alternative sources, including intake relocation or operational management; pretreatment by off-stream storage, bank filtration, presedimentation using coagulation, or lime softening; upgrades to filtration; and improved disinfection using chlorine dioxide, ozone or UV. All are defined and have treatment credits assigned, based on specific design and performance criteria.

Guidance manuals to assist compliance also were released for comment. These include the Source Water Monitoring Guidance Manual, the Microbial Laboratory Manual and a Guidance on Grandfathering *Cryptosporidium* Data. Treatment manuals include the LT2 Toolbox Guidance Manual, a Membrane Filtration Guidance Manual and a Guidance on Challenge Testing of Bag and Cartridge Filters and Membranes.

With specific respect to UV disinfection, USEPA is providing inactivation tables for *Giardia* lamblia, *Cryptosporidium* and viruses. Compliance standards include a UV treatment system validation protocol and requirements for on-site monitoring. A UV Disinfection Guidance Manual covers treatment plant design and operational issues.

Disinfection Profiling and Benchmarking

All surface water systems serving 10,000 or more people must conduct disinfection profiling of *Giardia* and virus inactivation, as was required for certain systems under the IESWTR. Systems serving fewer than 10,000 people, with some exceptions, also must conduct disinfection profiling. Systems that performed profiling under either the IESWTR or the LT1ESWTR may grandfather these data. A disinfection benchmark, based on the disinfection profile, must be calculated by all systems planning to make significant changes to their disinfection treatment.

Uncovered Finished Water Reservoirs

All uncovered finished water reservoirs must be covered or the reservoir discharge water treated to provide 99.99% (4-logs) virus inactivation. Under some circumstances, the primacy agency may in lieu of this require implementation of a risk management plan.

Implementation Schedule

Large systems must begin their monitoring activities within six months of rule promulgation. Bin classifications based on the monitoring results are due three years after promulgation. Compliance with treatment requirements begins six years after promulgation.

For systems serving fewer than 10,000 people, monitoring begins 30 months after promulgation. Bin classification follows at 5½ years and compliance at 8½ years after promulgation.

PROPOSED ELEMENTS OF THE S2DBPR

The general goal of the S2DBPR is to provide additional protection from elevated levels of disinfection byproducts found at localized points in distribution systems. Current standards that average results across a system's distribution system will be phased out and replaced with standards specific to each monitoring point. The regulatory elements include an initial assessment of byproduct levels in the distribution system, then reconsideration of monitoring locations, followed by monitoring and compliance based on locational running annual averages.

Initial Distribution System Evaluation (IDSE)

All community water systems, and non-transient non-community water systems that serve 10,000 or more people, that provide some form of disinfection (except UV) must conduct an evaluation of disinfection byproduct levels in their distribution systems. This includes both wholesalers and retailers, including consecutive systems that provide little or no additional treatment. The intention is to consider fully the combined distribution system. This evaluation consists of monitoring for TTHM and HAA5 throughout the distribution system according to an approved plan. It is in addition to and separate from normal compliance monitoring. The number and location of the monitoring sites, and the frequency and timing of sampling are determined by system size and characteristics. The details of this are extremely specific and beyond the scope of this article.

The results of the IDSE monitoring will be used to determine a new set of compliance monitoring points representative of the highest byproduct points in the distribution system. All data, analyses and determinations must be reported to the primacy agency, which then must approve the new monitoring plan.

Interim Locational Disinfection Byproduct MCLs

As systems undertake their IDSE, interim ("Stage 2A") MCLs will apply at each of the existing compliance monitoring points in the distribution system. These will be based on a locational running annual average of the monitoring results. These are in addition to the existing MCLs, which are based on the running annual averages across the entire distribution system. Beginning three years after promulgation and continuing until new compliance monitoring points are established and necessary treatment is in place, these locational MCLs are 120 Fg/L for TTHM and 100 Fg/L for HAA5.

Stage 2B Disinfection Byproduct MCLs

Following approval of the IDSE-based monitoring plan, systems must then comply with the lower TTHM and HAA5 MCLs currently applicable to the entire distribution system. These are 80 Fg/L for TTHM and 60 Fg/L for HAA5, based on the locational running annual average.

Relevant Stage 1 and Stage 2A TTHM and HAA5 standards then will sunset.

Significant Excursions

USEPA additionally is concerned about short-term byproduct levels much above the MCLs. Primacy agencies will have to determine what constitutes a "significant excursion" above these MCL levels. Systems that exceed the trigger values will be required to conduct and submit an evaluation of the factors leading to these excursions.

Implementation Schedule

Systems serving >10,000 people and all consecutive systems receiving treated water from a system serving >10,000 people must begin the IDSE within six months of rule promulgation. Final reports are due two years after promulgation. Final compliance with Stage 2b MCLs begins six years after promulgation, although states may grant an additional two years if major capital improvements are necessary in order to comply.

Systems serving 10,000 people or fewer begin their IDSEs 30 months following promulgation and must submit their final reports four years after promulgation. These systems must comply with Stage 2b MCLs within 7½ years after promulgation, unless they have to conduct *Cryptosporidium* monitoring. In this case, they have an additional year to comply. Again, the state may grant an additional two years if major capital improvements are necessary.

REFERENCES

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8. USEPA. Stage 2 Microbial and Disinfection Byproducts Federal Advisory Committee Agreement in Principle. FR 65, no 251, December 29, 2000.