



This paper is intended to describe:

- **Stage 1 Disinfectants/Disinfection Byproducts Rule (1998) and**
- **Stage 2 Disinfectants/Disinfection Byproducts Rule (2006).**

These U.S. regulations were developed and are enforced to improve public health protection by reducing exposure to disinfection byproducts.

Stage 1 Disinfectants/Disinfection Byproducts Rule (1998)

The purpose of the Stage 1 Disinfectants/Disinfection Byproducts Rule (Stage 1 DBPR) is to improve public health protection by reducing exposure to disinfection byproducts. Some disinfectants and disinfection byproducts (DBPs) have been shown to cause cancer and reproductive effects in laboratory animals and suggested bladder cancer and reproductive effects in humans. The Stage 1 DBPR is the first of a staged set of rules that will reduce the allowable levels of DBPs in drinking water. The rule establishes seven new standards and a treatment technique of enhanced coagulation or enhanced softening to further reduce DBP exposure. The rule is designed to limit capital investments and avoid major shifts in disinfection technologies until additional information is available on the occurrence and health effects of DBPs. The Stage 1 DBPR applies to all sizes of community water systems and non-transient non-community water systems that add a disinfectant to the drinking water during any part of the treatment process and transient non-community water systems that use chlorine dioxide. Major provisions of the Stage 1 DBPR, which was finalized in 1998 and became effective during January 2002, are as follows:

- The MCL for total trihalomethanes has been reduced from 0.1 mg/L to 0.08 mg/L.
- A new MCL of 0.06 mg/L has been established for total haloacetic acids.
- New MCLs have been established for total haloacetic acids, bromate (by-product of ozone), and chlorite ion (by-product of chlorine dioxide).
- Maximum residual disinfectant levels (MRDLs) and MRDL goals (MRDLGs) have been established for free chlorine, chloramine and chlorine dioxide.

Table 3-1 lists the MCLs, MRDLs, and MRDLGs for the regulated contaminants/disinfectants and the basis of compliance.

Table 3-1 Regulated Contaminants/Disinfectants and Basis of Compliance			
Contaminant	MCL, mg/L	MCLG, mg/L	Compliance
Total Trihalomethane (TTHM)	0.08	-	RAA Computed Quarterly of Quarterly Averages of All Samples
Chloroform		-	
Bromodichloromethane		0	
Dibromochloromethane		0.06	
Bromoform		0	
Five Haloacetic Acids (HAA5)	0.06	-	RAA Computed Quarterly of Quarterly Averages of All Samples
Monochloroacetic Acid		-	
Dichloroacetic Acid		0	
Trichloroacetic Acid		0.3	
Bromoacetic Acid		-	
Dibromoacetic Acid	-	-	-
Bromate	0.01	0	RAA Computed Quarterly of Monthly Samples.
Chlorite	1.0	0.08	Average of Each Three Sample Set

Table 3-1 (continued) Regulated Contaminants/Disinfectants and Basis of Compliance			
Disinfectant	MRDL, mg/L	MRDLG, mg/L	Compliance
Chlorine	4.0 as Cl ₂	4.0	RAA Computed Quarterly of Monthly Averages of All Samples
Chloramines	4.0 as Cl ₂	4.0	RAA Computed Quarterly of Monthly Averages of All Samples
Chlorine Dioxide	0.8	0.8	Consecutive Daily Samples

A primary goal of the Stage 1 DBPR is to reduce the levels of organic/humic compounds that react with chlorine-based disinfectants to form DBPs. This is accomplished through enhanced coagulation or enhanced softening, which involves increased coagulant dosages or adjustment of pH to optimize the removal of precursor compounds. Precursor removal is quantified by measuring TOC removal across the treatment process. In general, for systems with average source water TOC concentrations exceeding 2.0 mg/L, enhanced coagulation/enhanced softening treatment will be required. The minimum TOC removal levels are summarized in Table 3-2. TOC removals are to be determined monthly, and compliance is to be assessed quarterly based on a running annual average (RAA) of monthly TOC removals.

Table 3-2 TOC Removal Requirements for Enhanced Coagulation/Enhanced Softening			
Source Water TOC, mg/L	TOC Removal Based on Source Water Alkalinity as CaCO ₃ , %		
	0-60 mg/L	>60-120 mg/L	>120 mg/L ¹
>2.0-4.0	35	25	15
>4.0-8.0	45	35	25
>8.0	50	40	30
1. Systems practicing softening must meet the TOC removal requirements in this column.			

The Stage 1 DBPR also provides alternative compliance criteria that are independent of the criteria discussed above. Systems are exempt from the enhanced coagulation/enhanced softening requirements if any of the following criteria are met:

- Source water TOC <2.0 mg/L (calculated quarterly as RAA of monthly monitoring data).
- Source water TOC <4.0 mg/L, source water alkalinity >60 mg/L as CaCO₃, and system is achieving TTHM <0.04 mg/L and HAA5 <0.03 mg/L.
- Treated water TOC <2.0 mg/L (calculated quarterly as RAA).
- System's RAA TTHM <0.04 mg/L and annual average HAA5 <0.03 mg/L when only free chlorine is used for disinfection and maintaining residual in the distribution system.
- Source water SUVA ≤2.0 L/mg-m (calculated quarterly as RAA of monthly monitoring data).
- Treated water SUVA ≤2.0 L/mg-m (calculated quarterly as RAA of monthly monitoring data).

Systems that elect to utilize the alternative criteria are still required to conduct monthly raw and treated water TOC monitoring.

Table 3-3 lists the best available technology (BAT) for each MCL and MRDL established in the Stage 1 DBPR.

Table 3-3 Stage I DBPR Best Available Technology	
Disinfectant/DBP	Best Available Technology
Chlorine, chloramine, and chlorine dioxide	Control of treatment processes to reduce disinfectant demand and control of disinfection treatment processes to reduce disinfectant levels.
TTHM and HAA5	Enhanced coagulation/enhanced softening or granular activated carbon (GAC 10), with chlorine as the primary and residual disinfectant.
Chlorite	Control of treatment processes to reduce disinfectant demand and control of disinfection treatment processes to reduce disinfectant levels.
Bromate	Control of ozone treatment processes to reduce production of bromate.

Stage 2 Disinfectants/Disinfection Byproducts Rule (2006)

Congress required EPA to promulgate the Stage 2 Disinfectants/Disinfection Byproducts Rule (Stage 2 DBPR) as part of the 1996 amendments to the SDWA. The Stage 2 DBPR augments the Stage 1 DBPR and was developed to balance the benefits and risks posed by drinking water disinfection. The Stage 2 DBPR builds upon earlier rules that addressed disinfection byproducts to improve drinking water quality and provide additional public health protection from disinfection byproducts. This Rule strengthens public health protection by tightening compliance monitoring requirements for trihalomethanes (TTHM) and haloacetic acids (HAA5). The Rule applies to PWSs that are community water systems or non-transient non-community water systems that add a primary or residual disinfectant other than ultraviolet light or deliver water that has been treated with a primary or residual disinfectant other than ultraviolet light. The Stage 2 DBPR focuses on the following:

- Identifying locations in the distribution that have a high risk of DBP formation;
- Reducing exposure and lowering DBP peaks in the distribution system by using a new method to determine MCL compliance;
- Defining operational evaluation levels;
- Regulating consecutive systems.

Under the Stage 2 DBPR, systems will conduct an evaluation of their distribution systems, known as an Initial Distribution System Evaluation (IDSE), to identify the locations with high disinfection byproduct concentrations. Systems will develop an IDSE plan, collect data on DBP levels throughout their distribution system, evaluate these data to determine which sampling locations are most representative of high DBP levels, and compile this information into a report for submission to the State. Systems must complete one IDSE to meet the requirements of the Stage 2 DBPR. The locations with high disinfection byproduct concentrations will then be used by the systems as the sampling sites for Stage 2 DBPR compliance monitoring.

Review of disinfection by-products occurrence data obtained under the Information Collection Rule suggests that many systems have been achieving compliance with the original TTHM regulation by selecting quarterly monitoring dates to obtain samples that may not be representative of the actual variations in DBP formation that occur throughout the year. This was often accomplished by avoiding monitoring when water temperatures are warmest and when DBP formation rates are highest. The Advisory Committee developed recommendations regarding appropriate monitoring intervals to correct this problem under the Stage 2 DBPR. The Stage 2 DBPR MCLs would remain at the levels established under the Stage 1 rule, i.e., TTHMs=0.080 mg/L and HAA5=0.060 mg/L as an LRAA. Compliance with the MCLs for TTHM and HAA5 will be calculated for each monitoring location in the distribution system identified under the IDSE or using existing Stage 1 DBPR compliance monitoring locations. This LRAA approach differs from current requirements that determine compliance by calculating the RAA of samples from all monitoring locations across the system. Initial compliance efforts will focus on identifying points within the system where DBP concentrations are typically highest, and would involve the following:

- For systems serving 10,000 or more consumers; one year of monitoring of TTHM and HAA5 concentrations at 60-day intervals (±3 days) at eight additional locations within the distribution system.

- Systems served by more than one treatment facility would be required to monitor at eight locations per treatment plant.
- For systems that maintain a free chlorine residual within the distribution system, the eight monitoring sites per plant would consist of (1) one sample near the distribution system entry point, (2) two sites considered to reflect “average” system DBP concentrations, and (3) five sites considered to reflect “maximum” system DBP concentrations.
- For systems that maintain a chloramine residual within the distribution system, the eight monitoring sites per plant would consist of (1) two samples near the distribution system entry point, (2) two sites considered to reflect “average” system DBP concentrations, and (3) four sites considered to reflect “maximum” system DBP concentrations. This monitoring, referred to in the draft proposed regulation as the IDSE monitoring study, would be conducted in addition to the quarterly compliance monitoring conducted under the current TTHM regulation and the impending Stage 1 DBPR. A report summarizing the IDSE monitoring results must be submitted to the State within two years of promulgation of the Stage 2 DBPR. The draft proposed rule includes provisions for exemption from IDSE monitoring requirements, based on low historical system DBP concentrations.

Following completion of the IDSE, systems will recommend new or revised monitoring sites to their State/Primacy Agency based on their IDSE study. Monitoring site locations (four per system if served by a single treatment plant; four per system per plant if served by multiple treatment plants) are to be selected as follows:

- One location representative of average conditions from among current Stage 1 DBPR monitoring locations.
- One location representative of highest HAA5 concentrations identified under the IDSE.
- Two locations representative of highest TTHM concentrations identified under the IDSE.

Quarterly monitoring of DBP concentrations at four locations per plant within the distribution system would continue to be conducted for compliance monitoring purposes. At least one quarterly monitoring period would be required to reflect “peak historical” DBP formation level periods, and systems will be required to monitor on a regular schedule of approximately every 90 days. MCL compliance will be determined based on a LRAA basis, i.e., a running annual average must be calculated at each monitoring location.

Should an MCL be exceeded at one or more system monitoring points based on annual running average DBP concentrations, the system would be considered to be in violation of the Stage 2 regulation, regardless of results for the remaining monitoring sites. This represents a major change from current TTHM and Stage 1 DBP regulations, as the “system averaging” concept would be eliminated under the Stage 2 regulation.

During Stage 2 DBPR, systems that have completed one year of routine monitoring at IDSE sites, and that exhibit TTHM and HAA5 LRAA concentrations of no more than 0.040 mg/L and 0.030 mg/L, respectively, and annual average source water TOC levels of 4.0 mg/L or less will be allowed to reduce the number of DBP samples collected to two per quarter per treatment plant. For each quarterly sample pair, one sample would need to be collected at a location reflecting maximum TTHM levels, while the remaining sample would need to be collected at a location reflecting maximum HAA5 levels.

EPA has adopted the Advisory Committee’s recommendation that systems review peaks in TTHM and HAA5 concentrations that may occur in their distribution systems as part of the sanitary survey process. EPA defines a peak as any individual sample with a TTHM concentration of 0.100 mg/L or greater, and/or with an HAA5 concentration of 0.075 mg/L or greater. These values exceed the Stage 2 MCLs by 25 percent. Utilities experiencing these peaks would be required to work with their state primacy agencies to reduce the severity of these excursions; EPA will be preparing guidance for systems and State primacy agencies on how to conduct peak excursion evaluations and how to reduce peaks.

EPA proposed the following as Best Available Technology (BAT) for compliance with the TTHM and HAA5 LRAA MCLs when free chlorine is used as the primary and system residual disinfectant:

- GAC adsorbers with at least 10 minutes of empty bed contact time based on average daily flow and a carbon reactivation/replacement frequency of every 120 days.
- GAC adsorbers with at least 20 minutes of empty bed contact time based on average daily flow and a carbon reactivation/replacement frequency of every 240 days.
- Nanofiltration using a membrane with a molecular weight cutoff of 1,000 Dalton or less.

Considerable pressure to reduce the Stage 1 MCL for bromate to 0.005 mg/L or less currently exists, as ongoing research suggests that this contaminant may be more carcinogenic than originally believed. This change would primarily impact utilities practicing ozonation for primary disinfection and/or utilities that employ high dosages of sodium hypochlorite. EPA considered reducing the bromate MCL to 0.005 mg/L as an annual average but concluded that many systems using ozone to inactivate microbial pathogens would have significant difficulty maintaining bromate levels at or below 0.005 mg/L. In addition, because of the high doses required, the ability of systems to use ozone to meet *Cryptosporidium* treatment requirements under the LT2ESWTR would be diminished if the bromate MCL was decreased. EPA concluded that the existing MCL was justified. EPA will review the bromate MCL as part of the six-year review process under the SDWA and determine if the MCL should remain at 0.010 mg/L or be reduced to 0.005 mg/L or lower.

The Stage 2 DBPR requires each system to determine if they have exceeded an operational evaluation level, which is identified using their compliance monitoring results. The operational evaluation level provides an early warning of possible future MCL violations, which allows the system to take proactive steps to remain in compliance. A system that exceeds an operational evaluation level is required to review their operational practices and submit a report to their state that identifies actions that may be taken to mitigate future high DBP levels, particularly those that may jeopardize their compliance with the DBP MCLs.

The Stage 2 DBPR contains provisions for regulating consecutive systems, defined as PWSs that buy or otherwise receive some or all of their finished water from another PWS. Consecutive systems must provide water that meets the MCLs for TTHM and HAA5 under the Stage 2 DBPR, use specified analytical methods, and carry out associated monitoring, reporting, etc.

For more information regarding Initial Distribution System Evaluation (IDSE), contact Floyd Browne Group at 740-363-6792.