JUN 20 1991

STATUS REPORT ON DEVELOPMENT OF REGULATIONS FOR DISINFECTANTS AND DISINFECTION BY-PRODUCTS

The purpose of this document is to indicate the status of regulation development for the disinfectants (Ds) and disinfection by-products (DBPs) and to solicit feedback from the public. Previously, EPA made available to the public a "strawman" rule (October 1989) and a conceptual framework for developing these regulations (December 1990).

This document reflects EPA's current thinking on how the criteria for the D/DBP regulations are evolving. The document consists of four sections: 1) overview of anticipated general requirements of the rule and major issues, 2) fact sheet on the status of pertinent analytical methods, 3) fact sheet on the status of health effects information, and 4) draft compliance monitoring requirements.

EPA anticipates adhering to the following schedule in developing the D/DBP regulations:

• Agency approval of intent and scope of regulations:	December 1991
• Distribute draft rule to interested public:	February 1992
• Propose rule:	June 1993
• Promulgate rule:	June 1995

The information contained herein has not undergone formal Agency review. It is meant to elicit thoughts and information from the public to assist EPA in development of the regulations. EPA solicits comment on all the information and criteria described herein. All comments received by October 15, 1991 will be considered in the development of the Draft Rule. Comments received after November 15, 1991 will be considered in the development of the Proposed Rule. Comments should be sent to:

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OVERVIEW OF ANTICIPATED GENERAL REQUIREMENTS AND MAJOR ISSUES

GENERAL REQUIREMENTS

Applicability

The D/DBP regulations would apply to all public water systems (including noncommunity systems) using disinfection and serving non-transient populations. This is unlike the current maximum contaminant level (MCL) for total trihalomethanes (TTHMs) which only pertains to systems serving more than 10,000 people.

Compounds Likely To Be Regulated With MCLs[1]

trihalomethanes (THMs)[2]	-	chloroform, bromodichloromethane, chlorodibromomethane, bromoform
haloacetic acids (HAs)[3]	-	trichloroacetic acid, dichloroacetic acid
chloral hydrate		
bromate		
chlorine		
chloramines		
chlorine dioxide		
chlorate		
chlorite		

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[1] This list of compounds is significantly shorter than that included in the 1989 "strawman" rule. Some of the original compounds have been deleted because they do not appear to pose significant health risk at levels that occur in drinking waters (e.g., haloacetonitriles, chloropicrin). Other compounds have been deleted because their health risks will not be adequately characterized in time for this regulation. Such compounds may be regulated at a future date (e.g., certain aldehydes and organic peroxides) when more data become available.

[2] Three options are being considered: 1) MCLs for each of the four THMs, 2) an MCL for TTHMs, and 3) an MCL for each of the THMs and an MCL for TTHMs (which may be different from the sum of the individual THMs). Individual THMs are being considered because their health risks are significantly different from each other (see fact sheet on health effects), and the technical feasibility for limiting their formation can vary greatly for each of the compounds, depending upon source water quality. An MCL for TTHMs is being considered because of the precedent already established with the current TTHM standard, and to act as a surrogate regulation to limit other DBPs.

[3] Three options are being considered: 1) MCLs for trichloroacetic acid and dichloroacetic acid; 2) an MCL for total HAs including mono-, di-, and tri-chloroacetic acid; monobromo and dibromo acetic acid; and bromochloroacetic acid; and 3) the combination of options 1 and 2. A limit for total HAs is being considered because all the compounds can be measured at the same time using the same analytical method for no additional cost. A limit for total HAs would act as a surrogate to limit production of other HAs and DBPs for which health risks are not yet determined.

MAJOR ISSUES

Risk Trade-offs in Controlling for Pathogenic Organisms

Traditionally we have set drinking water standards for contaminants at the lowest possible number which is technically and economically feasible to achieve for most large systems. However, the Agency is in the process of reassessing the use of costs and cost-effectiveness for setting MCLs (e.g., see proposed Radionuclides Rule, June 17, 1991). In the case of regulating specific DBPs and disinfectants, setting an MCL based on what is technically and economically feasible to achieve raises several concerns.

Our goal is to ensure that drinking water remains microbiologically safe at the limits we set for disinfection by-products (DBPs) and disinfectants (Ds). Disinfection is essential for protection from waterborne disease. Therefore, we may have to accept greater risks from Ds/DBPs than for other contaminants EPA regulates. We are attempting to develop standards which minimize risk from both Ds/DBPs and pathogenic organisms.

To properly address this issue we would like to answer key questions during the development of our Proposed Rule:

- What are the uncertainties associated with defining microbial and D/DBP risks?
- How can we compare these risks with one another?
- What levels of DBP/D risk and microbiological risk are we willing to accept and at what cost?
- What are the most practical criteria available for defining the achievement of acceptable levels of risk in this rule?

Use of Alternative Disinfectants to Limit Chlorination DBPs

Certain combinations of alternative disinfectants to chlorine (e.g., ozonation and chloramines) can provide excellent disinfection of pathogens and greatly limit the formation of DBPs typical of chlorination such as THMs. However, we currently do not have a good understanding of the by-products formed from alternate disinfectants and of some of their associated health risks. EPA does not want to promulgate a standard which encourages the industry to switch to alternative disinfectants unless it is likely that their by-products pose substantially less risk than those from the by-products of chlorination.

Other concerns from alternative disinfectants relate to microbiological issues. For example, depending on the source water type and other technologies used, switching to ozone may increase availability of assimilable organic material and subsequently increase, with unknown risk, bacterial populations in distribution systems.

Different concerns pertain to chloramines. Since chloramines are a weak disinfectant, their use in lieu of chlorine for primary disinfection might significantly increase risk from microbial disease.

We are confronted with a unique situation where adoption of technologies to reduce one type of risk may increase another type of risk. Our ability to characterize these differences in risk is still fairly crude.

Integration With the Surface Water Treatment Rule (SWTR)

The SWTR requires systems using surface water to achieve at least 99.9% (3-log) and 99.99% (4-log) removal/inactivation of Giardia and viruses, respectively, although many systems now achieve much greater removals. EPA guidance to the SWTR recommends greater than 3/4-log removal/inactivation for poor source waters. EPA would not like to reduce that existing level of protection, unless there is an obvious overall risk reduction, taking by-products and disinfectants into consideration. Amendments to the SWTR, which would require higher levels of removal/inactivation for systems with poor source waters than the 3/4-log minimum, may be necessary to ensure adequate protection from pathogens while systems comply with the new regulations for disinfectants and disinfection by-products.

Best Available Technology

The Safe Drinking Water Act requires EPA to specify a maximum contaminant level goal (MCLG) for each contaminant that

it regulates. EPA must set the MCL as close to the MCLG as is technically and economically feasible to achieve and must specify in the rule such best available technology (BAT). Systems unable to meet the MCL after application of BAT can get a variance. Systems that obtain a variance must meet a schedule approved by the State for coming into compliance. Systems are not required to use BAT in order to comply with the MCL but can use other technologies as long as they meet all drinking water standards and are approved by the State.

How BAT is defined will determine the level at which MCLs are set for DBPs. Because health risks from by-products of alternate disinfectants are not as yet well characterized as they are for by-products of chlorination, it may be appropriate to define chlorination for primary disinfection and certain precursor removal technologies as BAT under this rulemaking. Examples of such technologies include: a) conventional treatment optimized for DBP precursor removal, b) granular activated carbon (GAC) as a filter media replacement, c) GAC following filtration, and d) membrane filtration. Other technologies for BAT consideration, depending upon the source water quality, include conventional treatment with use of alternate disinfectants such as ozone for primary disinfection and chloramines for residual disinfection.

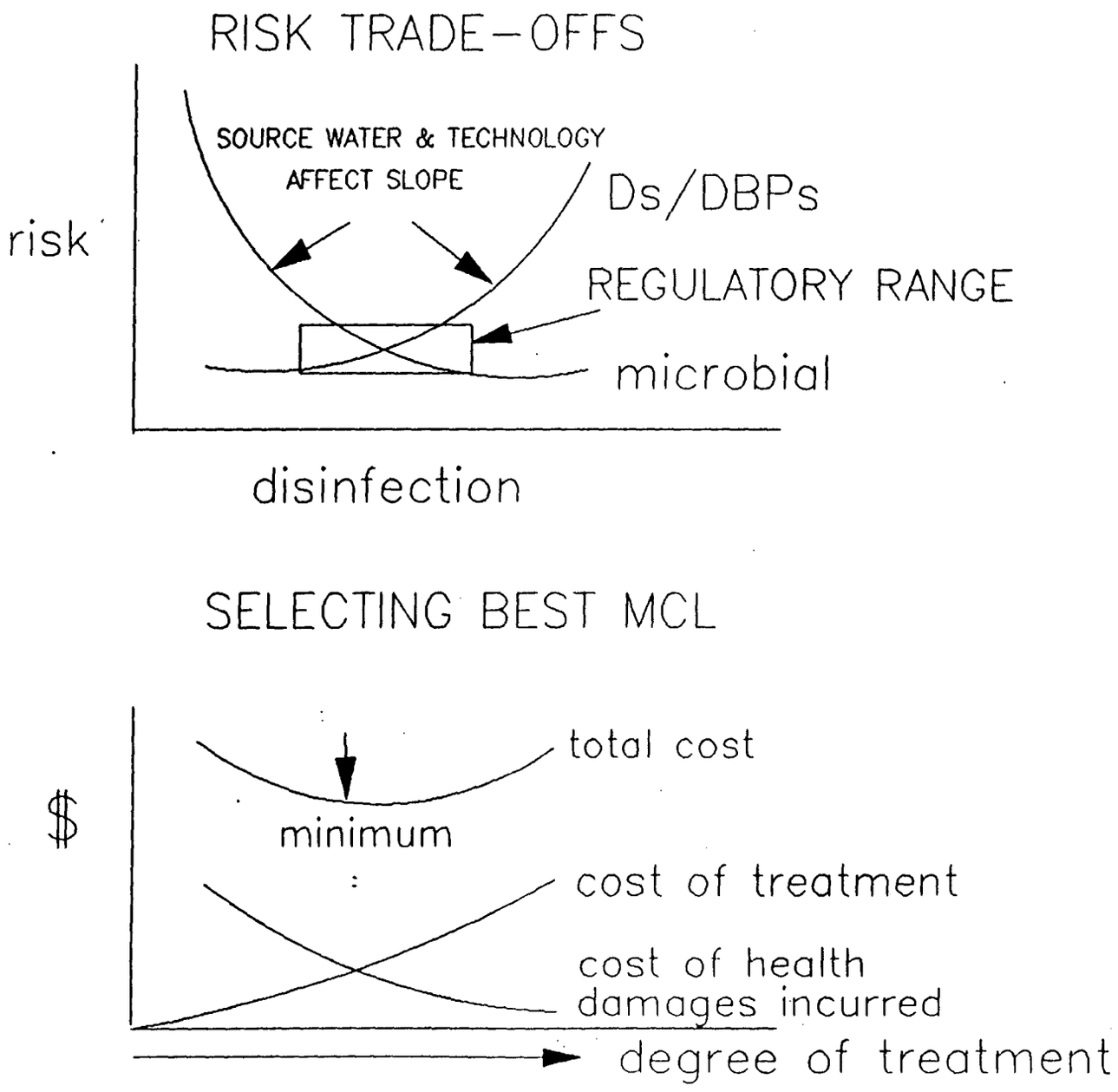
The cost and performance of the above technologies will vary greatly depending upon how they are designed and operated. The technical and economic feasibility of using these technologies to achieve different finished water quality targets (potential MCLs) can be greatly influenced by source water quality and system size.

Approach to Setting MCLs

EPA is attempting a risk/risk trade-off analysis between exposures from pathogens and Ds/DBPs for different regulatory options. This will help us arrive at the most cost-effective rule and determine how BAT should be defined. In order to resolve the problems of risk assessment comparison between these two types of health concerns, we are trying to determine the regulatory options which lead to the lowest total cost (see Figure 1). This approach should clearly define the uncertainties of risk for different options and help us to define how much we would be willing to pay to avoid such uncertainties.

Although we are in the early stages of our analysis, we believe the following outcomes will become evident: a) there are significant uncertainties in the risk from unknown DBPs in the lowest-cost treatment technology options, (e.g., conventional filtration processes followed by ozone with chloramines as a residual disinfectant); and b) the technologies that can

FIGURE 1


RISK TRADE-OFFS
SOURCE WATER & TECHNOLOGY
AFFECT SLOPE
Ds/DBPs
risk
REGULATORY RANGE
microbial
disinfection
SELECTING BEST MCL
total cost
$
minimum
cost of treatment
cost of health
damages incurred
degree of treatment

minimize exposure to risks from known and unknown pathogens and DBPs (e.g., filtration followed by granular activated carbon or membrane filtration with disinfection) are significantly more costly than technologies using conventional treatment and alternative disinfectants.

Lack of data pertaining to risk/risk trade-offs between pathogens and Ds/DBPs will significantly compromise our ability to estimate optimal regulatory targets within the current regulatory schedule (proposing in June 1993 and promulgating in June 1995). The level of stringency that is practical to achieve for chlorination DBPs at affordable costs is associated with potential increased risks from exposure to pathogens and DBPs from alternate disinfectants. Several regulatory strategies could address this issue within the current regulatory time frame.

Possible Regulatory Strategies

One strategy to address the uncertainty in risk trade-offs between protection from pathogens versus exposure to DBPs and disinfectants is to develop a regulation which defines the most effective DBP precursor removal technologies as BAT, e.g., granular activated carbon following filtration and membrane filtration. However, such a regulation would minimize health risk concerns at substantial costs without us knowing whether other less costly technologies could provide similar benefits, e.g., conventional treatment with alternative disinfectants. Such a regulation would also create pressure for a large number of variances for small systems.

Alternatively, we could develop a less stringent regulation until we are able to obtain more data and the cost-effectiveness of using higher cost versus lower cost treatment technologies becomes clearer. This latter approach would involve a two-phase regulation of potentially increasing stringency as more data become available.

Under the scenario of a two-phase regulation, BAT in the first phase of regulation (promulgation in June 1995) might be defined as conventional treatment optimized for precuror removal using chlorination for primary disinfection. Systems would have a variety of technical options other than the BAT to achieve compliance. The MCL would be based on what is feasible for the BAT to achieve on a selected source water quality. The source water quality selected for the basis of BAT determination might be that which represents the central tendency of source water quality in the U.S. regarding DBP precursor and pathogen occurrence.

BAT in the second phase of regulation (promulgation in June 2000) might be defined as filtration followed by GAC or membrane filtration and/or possible use of alternative disinfectants. If systems adopted precursor removal technologies such as granular activated carbon or membrane filtration in Phase I, they could be assured of being able to meet more stringent limits that might be set in Phase II. This strategy could facilitate adoption of the most cost-effective technologies for controlling DBPs as well as other regulated contaminants.

The total cost analysis mentioned above will help us understand the merits of different regulatory options, determine how to define BAT, and provide insight on whether to proceed with a two-phased regulatory approach. EPA intends to share the outcome of this analysis with the public in a Draft Rule anticipated to be released at the end of February 1992. EPA solicits comment on the above strategies and welcomes suggestions for other approaches to address the aforementioned issues.

FACT SHEET - ANALYTICAL METHODS

DISINFECTANTS AND DISINFECTION BY-PRODUCTS

June 1991

Methods for measuring disinfectant residuals and the concentrations of disinfection by-products in finished drinking water are under various stages of development. A summary of the status of the methods is presented below.

Background

Before a Maximum Contaminant Level (MCL) can be set for a drinking water contaminant, there must be at least one reliable method for measuring the concentration of the contaminant. In order for a method to be useful, it must provide reasonably precise and accurate measurements of the analyte at concentrations near the MCL. The method must be written in a standard format and it must undergo multilaboratory validation studies to determine interlaboratory performance. Performance evaluation (PE) samples must be prepared for use in the certification process as well as in the generation of interlaboratory performance data.

Summary of Analytical Methods

Disinfectants:

Chlorine and Chloramines. The following methods were specified in the Surface Water Treatment Rule (SWTR) for measuring free chlorine and combined chlorine (chloramines) residuals in disinfected drinking water: Method 408C (Amperometric Titration Method); Method 408D (DPD Ferrous Titrimetric Method); Method 408E (DPD Colorimetric Method); and Method 408F (Leuco Crystal Violet Method) as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition. The State Regulatory Agencies were given the option to approve the use of DPD colorimetric test kits. The applicability of these methods will be reevaluated for the Groundwater Disinfection Rule (GWDR). Chlorine is included in current EPA performance evaluation (PE) studies.

Issues: Interferences and other method limitations must be examined. New methods may need to be developed.

Guidance on defining what constitutes a "detectable" chlorine residual may need to be written, since the sensitivity varies with analytical method. The cited methods are also subject to interferences that could result in false positives.

There is no mechanism to ensure the free and combined

chlorine residual measurements are being done properly.

Chloramine is not yet included in PE studies.

References to methods need to be updated to the 17th edition of Standard Methods for the Examination of Water and Wastewater. Provisions must be made for continual updating as new versions are published.

Chlorine Dioxide. The SWTR specified the following methods for determining chlorine dioxide residual concentrations: Method 410B (Amperometric Method) or Method 410C (DPD Method) as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition.

Issues: Since EPA is developing separate risk assessments for chlorine dioxide and the inorganic by-products (chlorite and chlorate) as part of the Groundwater Disinfection Rule (GWDR) and the Disinfection By-Product (DBP) Rule, the chlorine dioxide methods must be reexamined to determine their applicability. The methods may not be sensitive enough to reliably measure the analytes at levels considered to have no adverse health effects.

Chlorine dioxide is not yet included in PE studies.

References to methods need to be updated to the 17th edition of Standard Methods for the Examination of Water and Wastewater. Provisions must be made for continual updating as new versions are published.

Ozone. The SWTR specified the residual disinfectant concentrations for ozone must be measured by the Indigo Method as set forth in Bader, H., Hoigne, J., "Determination of Ozone in Water by the Indigo Method; A Submitted Standard Method"; Ozone Science and Engineering, Vol. 4, pp. 169-176, Pergamon Press Ltd., 1982, or automated methods which are calibrated in reference to the results obtained by the Indigo Method. Two on-line measurement techniques are under development through the AWWA Research Foundation and they will be evaluated for applicability. Ozone residuals cannot be maintained in water, but monitoring of ozone residual and dose is necessary for determining CT credits.

Issues: The SWTR reference should be updated to Method 4500.03B as set forth in Standard Methods for the Examination of Water and Wastewater, 1989, American Public Health Association et al., 17th edition.

Ultraviolet Radiation. Since UV radiation is an effective disinfectant for viruses, EPA intends to allow the use of UV as a primary disinfectant in the GWDR.

Issue: One of the current limiting factors in its use is the inability to continuously monitor the UV dose being applied in the to the water by a standard method. Development of a UV sensor will be necessary before widespread use of UV can be encouraged.

Disinfection By-Products:

Trihalomethanes, Haloacetonitriles, Chloropropanones, Chloropicrin, & Chloral Hydrate. There are 2 methods approved for compliance monitoring of THM concentrations in finished drinking water (EPA Methods 501.1 and 501.2). These methods were published in the Federal Register in 1979, as part of the THM Rule. Due to many advances in gas chromatography, these methods are based on obsolete chromatography technology. Three additional methods are EPA-approved for measuring THM concentrations (EPA Methods 502, 524.1 and 524.2), but they have not been designated as compliance monitoring methods. The EPA is preparing a Federal Register notice to allow their use for compliance monitoring.

The EPA has also developed a new liquid/liquid extraction method, which can be used to measure 4 haloacetonitriles (HANs) (trichloroacetonitrile [TCAN], dichloroacetonitrile [DCAN], bromochloroacetonitrile [BCAN], and dibromoacetonitrile [DBAN]), 2 chloropropanones (1,1-dichloropropanone [DCP], and 1,1,1-trichloropropanone [TCP]), chloropicrin (CP), and chloral hydrate (CH), as well as the THMs. EPA Method 551 was published in Methods for the Determination of Organic Compounds, Supplement 1, EPA/600/4-90/020, July 1990, and several laboratories are using it to measure THMs and the other analytes. The method involves adjusting the ionic strength of the sample, extracting the analytes into methyl-tertiary-butyl ether (MTBE), and analyzing the extract by capillary column gas chromatography (GC) with electron capture detection (ECD).

In some matrices, a separate sample must be collected for chloral hydrate, because the regular dechlorinating agent interferes with its analysis.

THMs, HANs, DCP, and TCP are included in the PE studies. THMs, BCAN, TCP, and CH standards are available through EPA cooperative research and development agreements (CRADAs).

Method detection limits: All of the methods can easily meet MCL measurement requirements for THMs. The MDLs published in Method 551 are < 0.1 µg/L, and most laboratories will be able to reliably quantitate down to 1-5 µg/L.

Issues: Method 551 includes a preservation technique for HANs, CP, DCP, and TCP that is not viable for field use. (The procedure involves removing the free chlorine using NH_4Cl, then adjusting the sample pH to 4.5 using Hcl. Note: It is critical that the Ph not be lowered below this level, because free chlorine is again formed.) Further work on a preservation technique will be needed, if these compounds are to be regulated by setting MCLs.

Mixed standards should be included as part of the EPA CRADAs, if these compounds are regulated.

At this time EPA does not anticipate setting MCLs for HANs, CP, DCP and TCP.

There is very little data on the stability of the non-THM analytes in water samples, so sample holding times cannot be established.

CH and CP are not included in PE studies

CH analyses are complicated by the fact that working standards are not stable for longer than 1-2 weeks.

Haloacetic Acids & Chlorophenols. The EPA has developed a method to measure the concentrations of 6 haloacetic acids (monochloroacetic acid [MCAA], dichloroacetic acid [DCAA], trichloroacetic acid [TCAA], monobromoacetic acid [MBAA], dibromoacetic acid [DBAA], and bromochloroacetic acid [BCAA]) and 2 chlorophenols (2,4-dichlorophenol [24DCPh] and 2,4,6-trichlorophenol [246TCPh]. The method involves an acidic extraction with MTBE, conversion of the analytes to methyl esters using diazomethane, and analysis by capillary column GC/ECD. EPA Method 552 was published in Methods for the Determination of Organic Compounds in Drinking Water, Supplement 1, EPA/600/4-90/020, July 1990. It is in use at several laboratories around the country. The method incorporates an option of using a microextraction technique developed by Metropolitan Water District of Southern California. The PE studies include 5 of the HAAs and 246TCPh.

Method detection limits (MDLs): The MDLs published in the method are < 1.0 μg/L, and most laboratories will probably be able to reliably quantitate down to the 5-10 μg/L range for the HAAs.

Issues: The method requires the use of diazomethane, which is a problem for some laboratories due to safety concerns. An alternative derivatizing procedure is under development.

EPA has very little data on the stability of these compounds. Additional data on the HAAs are being collected, so EPA can specify a sample holding time.

Some drinking waters contain a contaminant (not yet identified) that interferes with the analysis of MCAA.

No commercial standards are available for BCAA or the other mixed bromo-chloro acetic acids that are probably also amenable to this method. Standards will have to be developed for these compounds.

Mixed standards of these compounds will be prepared as part of the new EPA CRADAs. Single compound standards should also be considered.

The method is subject to interferences that chromatograph in the same general areas as the chlorophenols. This complicates the analysis and sometimes requires the use of mass spectrometry to verify that the peak is not a chlorophenol.

Cyanogen Chloride. EPA Method 524.2, published in Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December 1988, can be used to measure CNCl concentrations in water, if the dechlorinating/preservation technique is modified. Ascorbic acid is the only dechlorinating agent that can be used with samples for CNCl analysis, and the sample should not be acidified with HCl. Analyses involve the use of purge and trap (P&T), capillary column GC with mass spectrometry (MS). Laboratories experienced in analyzing drinking water for vinyl chloride will have the least difficulty successfully analyzing for cyanogen chloride.

Method detection limits: EPA can quantitate down to 0.3 μg/L.

Issues: This compound is not stable in some water matrices. Determining a preservative for CNCl will require extensive research.

Cyanogen chloride is not included in current PE studies.

Some purge & trap units cannot be used for CNCl analyses because too much water is carried to the GC column. Efforts to eliminate this problem are under way.

Colorimetric methods are available for this compound, but they don't have the sensitivity required for drinking water. There is no research planned in this area, unless it is identified as a high priority.

Aldehydes. The draft EPA Method 554 can be used to measure the concentrations of carbonyl compounds in drinking water using high performance liquid chromatography (HPLC). The sample is buffered to pH 3, derivatized with 2,4-dinitrophenylhydrazine (DNPH), and passed through reverse phase C_{18} bonded silica cartridges. Ethanol is used to elute the analytes and they are quantitated using HPLC.

In addition to that method, a gas chromatography (GC) method is being used by EPA for treatment, occurrence, and monitoring studies. The method is based on the procedure described by Glaze et.al. in Environ. Sci. Technol., Vol 23, 838-847, 1989. The aldehydes are converted to oximes via an aqueous phase derivatization with O-(2,3,4,5,6-pentafluorobenzyl)hydroxylamine hydrochloride (PFBOA) and the oximes are extracted into hexane. Quantitation is accomplished via capillary column GC/ECD or GC/MS.

Method detection limits: The HPLC method lists MDLs in the range of 5-70 μg/L (formaldehyde = 8; acetaldehyde = 69), and the GC method provides MDLs around 1 μg/L.

Issues: Sample stability is a major concern for this method, and will require extensive research before it is resolved.

The HPLC method may not be sensitive enough for drinking water applications. If MCLs are set for certain

aldehydes and they are < 50 μg/L for individual compounds, the GC method may be the only method available.

The HPLC method has not been used to measure glyoxal and methylglyoxal concentrations.

It is unlikely aldehydes can be included in PE studies in the near future, due to stability and analytical method problems.

Chlorite, Chlorate, Bromate, & Iodate. EPA has a draft ion chromatography (IC) method (EPA Method 300.0B) for measuring chlorite, chlorate, and bromate. A flow injection analytical technique is also under development. Work is under way to include iodate in the IC method. Chlorite, chlorate, and bromate will be added to PE studies in near future.

Method detection limits: The method lists MDLs in the range of 3-20 μg/L (chlorate < chlorite < bromate).

Issues: Stability problems have been identified with chlorite, so the method specifies immediate analysis. Work is in progress to determine a preservative for this analyte.

Iodate requires additional study before it can be added to PE studies.

It is unlikely that any of these contaminants can be reliably quantified at < 10 μg/L in complex drinking water matrices using the current method. Research is underway to lower detection limits.

Organic Peroxides. One of the concerns about the use of ozone as a primary disinfectant is the theoretical possibility of forming organic peroxides. Since analytical methods sensitive enough to detect these types of compounds are not available, no one has been able to demonstrate whether they occur. EPA is determining the feasibility of developing methods based on electrochemical techniques for detecting these compounds. An internal report will be available in 1 year. If development of a method(s) is feasible, this will be a long range research project.

MX [3-Chloro-4(dichloromethyl)5-hydroxy-2(5H) furanone]. The analytical procedures used to measure the concentrations of this and similar compounds in drinking water are too complex for routine use. Extensive research would be required, with no guarantee of success, to develop a "rugged" method for MX. No research on methods is planned.

N-Organochloramines & Nitrosamines. There are no methods available to measure the concentrations of these compounds at the levels they may be expected to occur in drinking water. Before extensive research in this area can occur, specific target compounds must be identified. Method development will focus on techniques useful in research type

situations, since the goal is to determine whether these types of compounds are formed during the treatment of drinking water. If research indicates they are formed at concentrations of health significance, then further methods development work may be necessary.

N-oxy Compounds. Chloropicrin is the only compound of this type for which an analytical method is available. Research indicates chloropicrin forms in higher concentrations when ozonation is used during the treatment process. There is concern that other compounds may also be formed as the result of ozonation followed by chlorination or chloramination. A method for detecting these types of compounds is needed to assure they are not being formed at concentrations of health significance. This is a long term research project.

Surrogate Measurements:

EPA is considering the use of surrogate measurements as indicators of situations in which DBP monitoring requirements may be reduced or waived. Some of the surrogates being considered are described below.

Total Organic Halide. A study of 30 drinking water utilities treating surface water indicated total organic halide (TOX) may be a good surrogate for the sum of the chlorination by-products being considered for regulation. If this analysis is used as a screening technique or factored into the monitoring requirements of the DBP Rule in some other way, EPA may need to evaluate the performance of EPA Method 450.1 and include TOX in the PE studies. The THM samples currently included in PE studies might be applicable for TOX measurements and should be evaluated.

Source Water Quality. The organic load of the source water (as indicated by measurements of either dissolved organic carbon [DOC], or nonpurgeable organic carbon [NPOC] concentrations or UV absorbance at 254 nm) provides information about DBP precursors. If such measurements are used as a basis for granting monitoring waivers, the methods may need to be evaluated.

Bromide ions in source water react with ozone or chlorine to form such DBPs as bromate, bromoform, and dibromoacetic acid. Bromide concentrations can be measured using ion chromatography.

FACT SHEET - HEALTH EFFECTS

DISINFECTANTS AND DISINFECTION BY-PRODUCTS

June 1991

The Environmental Protection Agency (EPA) is in the process of assessing the potential health risks of several drinking water disinfectants and their by-products in anticipation of proposing regulations in June 1993. The following is a summary of the health assessment of these compounds and steps that need to be followed prior to proposal.

Background

The EPA is responsible for the protection of public water supplies as mandated by the Safe Drinking Water Act (SDWA) of 1974, amended in 1986. The SDWA requires EPA to regulate those contaminants that may pose an adverse human health risk and are known or anticipated to occur in drinking water. For each contaminant considered for regulation, the EPA determines a Maximum Contaminant Level Goal (MCLG) and a Maximum Contaminant Level (MCL) or, if monitoring is not feasible, a treatment technique.

The MCLG is a nonenforceable health-based goal that is considered protective of human health over a lifetime exposure and which provides an adequate margin of safety. The EPA has established a three-category approach for setting MCLGs. Factors such as weight of evidence for carcinogenicity, cancer potency, exposure, pharmacokinetics and mechanism of action influence the category in which a contaminant is placed. For category I contaminants, there is strong evidence of a carcinogenic risk to humans from a drinking water source; thus the MCLG is set at zero. For category II contaminants, there is limited evidence of a carcinogenic risk to humans exposed to the contaminant in drinking water. The MCLG determined for this group is based on the Reference dose (RfD) approach (described below) with an additional uncertainty factor applied to account for possible carcinogenicity. If adequate data are not available to calculate an RfD, then the MCLG is set using cancer risk information. For contaminants with inadequate or no evidence of carcinogenicity to humans via drinking water, the MCLG is determined from the RfD approach.

The RfD represents a daily oral exposure to a contaminant that would not result in an adverse health effect in the human population over a lifetime of exposure. The RfD incorporates a margin of safety and protects sensitive members of the population. The RfD is calculated

from a no- or lowest-observed-adverse-effect level identified from an appropriate study in humans or animals, and divided by an uncertainty factor. The uncertainty factor accounts for differences in response to toxicity within the human population and between humans and animals, as well as the quality and totality of the data base and the type of toxic effect. To represent a drinking water exposure, the RfD is adjusted for an adult drinking 2 liters of water per day as an average over a lifetime. The resulting value is called the Drinking Water Equivalent Level (DWEL). The DWEL assumes that all of one's exposure comes from a drinking water source. However, exposure to a given contaminant may also come from other sources; thus, the DWEL is adjusted to reflect a known or assumed level of exposure to the contaminant from a drinking water source. This value represents the MCLG.

The MCL is then set as close to the MCLG as feasible, based on the ability of different technologies to measure and remove the contaminant from water. Often the MCL will equal the MCLG. In cases where the MCLG is set at zero, the MCL will usually fall in an excess cancer risk range of one in ten thousand to one in one million (10^{-4} to 10^{-6}).

Summary of Health Information

Disinfectants:

Chlorine. Most commonly used disinfectant. It is a strong oxidizing agent and reacts with water to form hypochlorous acid and hypochlorite. In addition, chlorine reacts with organic matter in the water (e.g., humic and fulvic acids) to form a number of oxidation by-products.

Health effects: Toxic effects observed in animal studies with chlorine or hypochlorite include decreased organ and body weights, and changes in serum enzymes. These effects were observed in animals exposed to much higher levels of chlorine than would be found in drinking water. Early reports indicated effects on serum cholesterol, these findings were not confirmed in follow-up studies by the same authors. A two-year bioassay with chlorinated water in rodents reported a significant increased incidence of mononuclear cell leukemia in female rats exposed only to the mid-dose. The incidence does not appear to be dose-related for this lesion.

Epidemiology studies have associated chlorinated water with an increased risk of bladder, colon and rectal cancer in persons exposed for 40 years or more. The International Agency for Research on Cancer (IARC), however, recently

determined that these data are inadequate to classify the carcinogenicity potential of chlorinated drinking water to humans. They recommended further research to clarify this issue.

Risk Assessment: The EPA has not determined an RfD for noncancer health effects or cancer assessment for chlorine at this time. Health effects do not appear to be associated with typical residual chlorine levels in public water supplies.

Future steps: Review new data on reproductive and immunological effects. Determine RfD for chlorine in Summer, 1991; initiate review of carcinogenicity of chlorinated water in Summer, 1991. Science Advisory Board review possibly in October, 1991.

Chloramine. Chloramines are a common alternative to chlorine for disinfection. Chloramines are not as strong an oxidizer and are less reactive than chlorine in water. They do, however, react with organic matter in water to form oxidation by-products. The level of by-products formed is less than that produced with chlorine.

Health Effects: The health effects associated with high levels of chloramine given to animals are changes in blood chemistry parameters and decreases in organ and body weights. A two-year drinking water bioassay with chloramine in rodents reported a dose-related increase in the incidence of mononuclear cell leukemia in female rats.

In humans, exposure to high levels of chloramines may result in some skin, eye and lung irritations. No adverse health effects were noted in persons drinking chloraminated water at levels typically used for disinfection.

Risk Assessment: The EPA has not determined an RfD for noncancer health effects or cancer assessment for chloramines at this time. Health effects do not appear to be associated with levels of residual chloramine typically found in drinking water.

Future steps: Review new data on immunological effects. Determine RfD for chloramines in Summer, 1991; initiate review of carcinogenicity of chloraminated water in Summer, 1991; Science Advisory Board review possibly in October, 1991.

Chlorine Dioxide, Chlorite and Chlorate: Chlorine dioxide is a strong oxidizing agent that has been used along with chlorine to disinfect drinking water and control phenol-related tastes and odors in the water. Use of

chlorine dioxide as a disinfectant does not result in the formation of oxidation by-products found with use of chlorine. Chlorine dioxide rapidly breaks down to chlorite and to some extent chlorate and chloride.

Health Effects: The health effects in animals exposed to high levels of chlorine dioxide and its by-products, chlorite and chlorate, include damage to red blood cells and effects on the thyroid. Delayed neurodevelopment has also been reported in young rats whose mothers were given high levels of chlorine dioxide in their water.

No health effects have been observed in healthy humans drinking water that has been disinfected with chlorine dioxide. However, persons deficient in a liver enzyme, glucose 6 phosphate dehydrogenase, may be at risk of developing anemia if they drink water treated with chlorine dioxide for a long period of time.

Risk assessment: The EPA has not determined an RfD or cancer assessment for chlorine dioxide, chlorite and chlorate at this time. The EPA published a guidance level in 1979, recommending that total residual oxidants not exceed 1 ppm in water when chlorine dioxide is used. EPA will develop separate risk assessments for chlorine dioxide, chlorite and chlorate that will likely be lower than the 1 ppm guidance level. This new level could preclude the use of chlorine dioxide as a residual disinfectant.

Future steps: Determine and verify an RfD for each chemical in Summer, 1991. Science Advisory Board review to be scheduled in late 1991 or early 1992.

Ozone: Ozone is another disinfectant for drinking water that is commonly used in Europe with increasing use in the US. It breaks down rapidly in water so that a residual is not maintained. Thus, it may be used in conjunction with another disinfectant such as chlorine or chloramine.

Health effects: Very little health effects information is available on ozone. Ozone has been tested for mutagenic activity. The results have generally been negative.

Risk assessment: The EPA has not determined an RfD or cancer assessment for ozone. It is unlikely that EPA will regulate ozone since a residual concentration is not maintained in the distribution system.

Future steps: Initiate research on the potential health effects to humans consuming ozonated drinking water.

Disinfection By-Products:

Trihalomethanes: The trihalomethanes (THMs) consisting of chloroform, bromoform, bromodichloromethane and dibromochloromethane are the most commonly occurring by-products of disinfection. They result from the reaction of chlorine or chloramines with organic matter in the water.

Health Effects: Animals studies have shown that exposure to high levels of THMs can effect liver and kidney function. Long-term exposure to high levels of the individual THMs has resulted in liver, kidney and intestinal tumors in rodents.

Risk Assessments: The EPA has determined RfDs of 0.01 mg/kg/d for chloroform and 0.02 mg/kg/d for bromoform, bromodichloromethane and dibromochloromethane. The EPA has also determined that there is sufficient evidence of carcinogenicity in animals to place chloroform, bromodichloromethane and bromoform in Group B2: probable human carcinogen. Dibromochloromethane has been placed in Group C: possible human carcinogen based on limited evidence of carcinogenicity in animals. The estimated excess cancer risk range is:

Chemical	Risk Range 10^{-4} to 10^{-6}
Chloroform	0.6 to 0.006 ppm
Bromodichloromethane	0.03 to 0.0003 ppm
Bromoform	0.4 to 0.004 ppm

The EPA established an MCL for total THMs in 1979 of 0.1 ppm. This level was based on the toxicity of chloroform in the absence of data for the brominated THMs. With the availablity of information for all four compounds, the current MCL may be revised to determine a separate MCL for each compound.

Future steps: Reevaluate the cancer risk assessment for chloroform to consider new information on pharmacokinetics. Reconsider the RfDs for the brominated THMs based on the Science Advisory Board's recommendations from the October 1990 meeting.

Halo-Acetic Acids: The halo-acetic acids, consisting of mono- (MCA), di- (DCA) and trichloroacetic acid (TCA) and various brominated forms are also commonly occurring by-

products of disinfection. DCA has also been used therapeutically to control abnormal metabolism in humans.

Health Effects: Health effects data for the brominated acetic acids and MCA are limited. Effects noted in animals exposed to high levels of DCA include metabolic changes, neurological effects such as muscle weakness, numbness, tremors and liver tumors in rodents following long-term exposure to very high levels. Studies in animals exposed to high levels of TCA indicated changes in enzyme levels and body weight gain. Limited evidence of liver tumors were also observed in rodents given very high levels of TCA in drinking water for 2 years.

Numbness and tingling sensations were reported in patients given therapeutic doses of DCA. These symptoms disappeared when treatment was discontinued.

Risk assessment: EPA has not determined an RfD or cancer assessment for the chlorinated acetic acids at this time.

Future steps: Conduct research on the potential health risks of brominated acetic acids. Determine RfDs for DCA and TCA in Summer, 1991. Evaluate new data for MCA. Initiate evaluation of carcinogenicity for DCA and TCA particularly in reference to a possible threshold mechanism. The Science Advisory Board will review cancer and neurotoxicity issues for DCA and TCA in April, 1991.

Ozone by-products: Formaldehyde and bromate are representative of ozone by-products. Formaldehyde has also been shown to increase in concentration following chlorination.

Formaldehyde has been classified in Group B1: probable human carcinogen based on limited human data and sufficient animal data showing nasal lesions following inhalation exposure. Formaldehyde exposure from ingestion does not appear to have a carcinogenic potential. The EPA has verified an RfD of 0.2 mg/kg/d based on absence of effects on weight gain and stomach in rats given formaldehyde in drinking water. Adjusting for an adult, water consumption and exposure from water, EPA has developed a Lifetime Health Advisory of 0.1 mg/L.

Bromate has not been extensively studied. Available data indicate that oral exposure to bromate in water can result in an increased incidence of kidney tumors in male and female rats and an increase in peritoneal mesotheliomas in male rats. The EPA has not formally assessed the weight of evidence or quantitative risk for bromate

carcinogenicity. A review will be initiated in the Summer of 1991. Data on noncarcinogenic effects are not available.

Low Occurring Disinfection By-products: There are several other by-products produced from disinfection that occur in lesser frequency and concentration than the THMs or halo-acetic acids. This group includes bromate, chloropicrin, chloral hydrate, cyanogen chloride and the haloacetonitriles.

Chloral hydrate, also known as trichloroacetaldehyde monohydrate, has been used as a seditive in humans. Effects in animals given high doses has produced changes in liver size and weight. Preliminary results from a cancer bioassay in rodents suggest some pctential for carcinogenicity. The EPA has determined a Refernece dose of 0.0016 mg/kg/d for chloral hydrate. Further evaluation of the cancer data will be initiated upon publication of the results.

Cyanogen chloride is an unstable by-product of chloamination. It has also been used as a nerve gas agent, particularly in WWI. The data base for cyanogen chloride dates back to the 1920's and is inadequate to use in determining a risk assessment. The EPA has determined a Reference dose for cyanogen chloride based on the toxicity of hydrogen cyanide resulting in a value of 0.02 mg/kg/d. The EPA will reevaluate the RfD based on the recommendations to be made by the Science Advisory Board.

EPA has not determined Reference doses or cancer assessments for **chloropicrin** or the **haloacetonitriles** at this time. The haloacetonitriles have been shown to produce effects in rat fetuses whose mothers were given water containing high levels of the compounds. EPA is presently evaluating new information on chloropicrin.

DRAFT COMPLIANCE MONITORING REQUIREMENTS

UNDER CONSIDERATION FOR

DISINFECTANTS AND DISINFECTION BY-PRODUCTS

June 1991

Background

The Disinfectants and Disinfection By-Products Rule will have monitoring requirements for disinfectants and for organic and inorganic by-products of disinfection (e.g., trihalomethanes and chlorate). The requirements will apply to over 50,000 public water systems that use disinfection (including those that purchase water from other systems).

EPA estimates that about 90% of the systems affected will be very small ground-water systems that serve less than 500 people. Because of the characteristics unique to most of these systems (low variability of the already low organic content in the source water, small distribution systems), EPA will require fewer samples to characterize disinfectant and disinfection by-product (DBP) occurrence at those systems. EPA also intends to allow some systems with low vulnerability to significant DBP formation to qualify for monitoring waivers for some by-products.

Approximately 80% of the U.S. population is currently served by about 3000 large systems that disinfect. These large systems must comply with the monitoring requirements of the Trihalomethane (THM) Rule of 1979. To do so, they have selected sample collection points, designed compliance monitoring procedures, and are now paying about $65 per sample for measurement of THMs. The new monitoring requirements will result in additional analytical costs for these systems; most of the new costs are anticipated to result from measurement of haloacids ($200), chloral hydrate ($75), and chlorine dioxide ($50) (prices are per sample). Costs for measurement of other by-products, disinfectants, and some surrogates are indicated in Table 1.

In addition to absorbing the per sample analytical costs, small systems (serving populations of less than 10,000) will have to set up sample collection and data reporting procedures to meet the new monitoring requirements.

TABLE 1. ANALYTICAL COSTS - 1991 DOLLARS

ANALYTE OR PARAMETER	COST($)/SAMPLE
Source Water Quality Indicators	
Total Organic Carbon (TOC) (nonpurgeable)	40
Ultraviolet (UV) Absorption	< 10
Bromide	30
Total Organic Halogen (TOX)	100
Formation Potential Studies (FP)	150-500
Organic & Inorganic By-Products	
Trihalomethanes (THMs)	65
Haloacetic Acids (HAAs)	200
Chloral Hydrate (CH)	75
Bromate, Chlorate, Chlorite ($25 each)	75
Disinfectants	
Chlorine	< 10
Chloramines	< 10
Chlorine Dioxide (includes Chlorite & Chlorate)	50

General Conditions of the Monitoring Requirements

1. The rule will specify minimum monitoring requirements but will also allow systems to sample more frequently and at more locations to determine compliance. To sample more frequently, the system must submit a map of all sampling locations, reasons for the frequency selected, and the formula that will be used to calculate a running annual average concentration for each organic by-product and an annual average concentration for each disinfectant and inorganic by-product. This plan, when approved by the State, must be used to measure all disinfectants and by-products for which the system must monitor.

2. A system using ground water under the direct influence of a surface water will have the same requirements as a surface water system.

3. When monitoring is less frequent than quarterly or the number of samples per collection period is less than four, the system must select a sample point and sampling time that are expected to produce the highest concentration of by-product. This is defined as being during the month of warmest water temperature, and at remote points in the distribution system.

4. A ground-water system may (with State approval) elect to determine compliance for disinfection by-products (except the inorganics) with one annual formation potential sample.

Summary of Compliance Monitoring Requirements

- STANDARDIZED MONITORING

  Although the Agency's Standardized Monitoring Framework does not apply to the disinfectants and disinfection by-products, the monitoring requirements described herein fit relatively well within the Framework. Portions of the Framework that are compatible with the monitoring criteria being developed include:

  - Monitoring is a system responsibility unless the State accepts responsibility.

  - Waivers (by Rule, by Use and by Susceptibility)

are granted by the State. They are used to permit no or reduced monitoring.

- There are always base monitoring requirements that a system must comply with whenever a waiver is not obtained or renewed.

- Initial monitoring begins on a January 1st.

- Initial monitoring is phased in over three years and States submit a compliance schedule. Phase-in by system size is not required.

- Reduced monitoring cycles are in multiples of three years. However, some monitoring frequencies may be as low as once every nine years depending on the vulnerability of the system to the by-product(s) of concern.

EPA is not planning to adopt the Standardized Monitoring Framework per se for this rule. To do so would delay initial monitoring until January 1999 for systems that now disinfect. For that particular deadline, EPA is considering January 1, 1997, instead.

o WAIVERS

- In general, all systems using a chemical disinfectant must monitor for the disinfectant and possible by-products. A system cannot receive a waiver from disinfectant monitoring but may obtain waivers from some or all by-product monitoring. Exceptions to this are that systems using ozone will not be required to measure ozone residuals under this rule; they will only have to measure for by-products (unless waivers are obtained). Systems that use only ultraviolet (UV) radiation will not be subject to any monitoring requirements under this rule. They will have monitoring requirements to characterize the effectiveness of UV disinfection under the Ground-Water Disinfection Rule.

- Systems that annually conduct monitoring of total organic carbon (TOC), bromide, and UV absorbance (all relatively inexpensive), or other indicators of by-product formation potential, may be able to obtain a waiver from some by-product measurements.

- Systems with certain types of pH control, or that can demonstrate predictable DBP formation

correlations with other by-products or parameters may receive a waiver from some or all by-product monitoring.

- Systems whose samples are reliably and consistently below a "trigger" percentage of the maximum contaminant level (MCL) for certain DBPs may be able to obtain a waiver from some by-product measurements.

- Waivers to allow reduced monitoring frequencies must be regularly renewed. They are not automatically granted when prior monitoring data is below the trigger concentration. To qualify for reduced monitoring, the State must concur, and there must be no significant change in source water quality or treatment during the waiver period.

- Possible waiver criteria for "no monitoring" waivers (i.e, waivers that would allow systems to avoid monitoring for some or all DBPs) are listed in Table 2. Possible criteria for reduced frequency monitoring waivers for DBPs are shown in Tables 3 and 4.

TABLE 2. FOUR POSSIBLE WAIVER CRITERIA

Systems may be allowed to avoid measuring some DBPs if one or more of the following criteria are met, subject to State approval. A waiver generally must be renewed every year or at the end of the reporting period.

1. Raw water quality. If the source water (or water prior to disinfection) falls below certain levels [to be determined] for certain combinations [to be determined] of the following parameters:

TOC < "x"
UV absorbance < "x"

then monitoring for certain DBPs may be waived.

2. Other water quality criteria. If the criteria below [to be determined] are met for any of the DBPs specified, then monitoring for those DBPs is not required.

Waiver For	Raw Water Criteria	Finished Water Criteria
Haloacetic Acids		pH ≥ "x" and/or [Acids] < T% MCL
Bromate	Bromide < "x"	No hypochlorination No use of ozone
Chloral Hydrate		[Chloroform] < T% MCL

3. Surrogates in finished water. If the ratio of TTHM/TOX is [required relationship to be determined] and pH and temperature are within [range to be determined] and [range to be determined], respectively, then DBP monitoring is not required.

4. Membrane treatment. If certain membrane processes are used, no DBP monitoring is required.

TABLE 3. POSSIBLE MONITORING REQUIREMENTS: ORGANIC BY-PRODUCTS
(Based on 1979 THM Rule)

System Size: Population ≥ 10,000

Water Source:	Surface Water	Ground Water
Number of Samples:	4[a]	4[a] or FP[b]
Sample Frequency:	Quarterly	Quarterly
Reduction Criteria[c]:	Annual average < MCL	Annual average < MCL or FP[b] < MCL
Reduced Frequency:	1/quarter (worst-case sample)	1/quarter (worst-case sample)

Compliance: See text at page 8.

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[a]Four samples taken at THM sample locations.

[b]One formation potential sample.

[c]Assumes no change in treatment or source water quality, and State concurs.

TABLE 4. POSSIBLE MONITORING REQUIREMENTS: ORGANIC BY-PRODUCTS

System Size: Population < 10,000

Water Source:	Surface Water	Ground Water
Sample Location/Time:	Worst-case sample from distribution system	Worst-case sample from distribution system
Sample Frequency:	1/quarter	1/year
Reduction Criteria[a]:	Annual average < 50% MCL or < 25% MCL	Each sample < 50% MCL for 3 yrs or one sample < 25% MCL for 1 yr
Reduced Frequency:	1/yr or 1/3 yrs, respectively	1/3 yrs or 1/9 yrs, respectively

Compliance: See text at page 8.

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[a]Assumes no change in treatment or source water quality, and State concurs.

MONITORING FOR ORGANIC BY-PRODUCTS

Chloral hydrate, haloacetic acids, and trihalomethanes (Tables 3 and 4; Figures 1, 2, and 3):

The requirements have been divided first by population served, and second by type of source water used (ground water or surface water).

- Initial monitoring at large systems is at the same frequencies and sample points used in the 1979 THM Rule.

- Initial monitoring at small systems requires only one sample per sampling period.

- Reduced monitoring requires a system to base compliance on worst-case samples. However, this should work very well for the large majority of systems eligible for reduced monitoring. These systems are mostly very small ground-water systems (the majority with populations less than 500) and have low and relatively constant concentrations of precursors in the source water.

FIGURE 1

MONITORING FOR DISINFECTION BY-PRODUCTS
SYSTEM SIZE: POPULATION ≥ 10,000

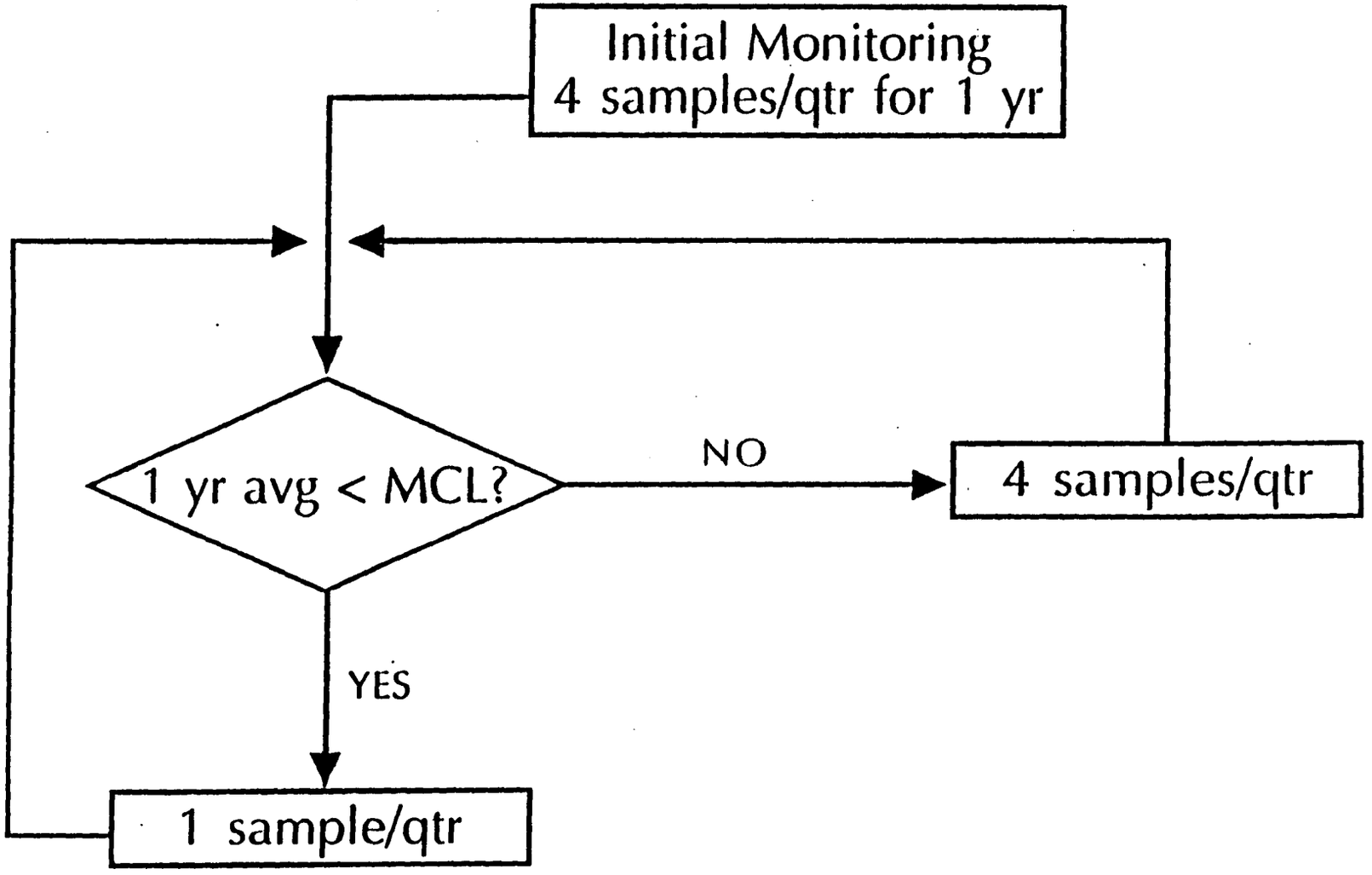


FIGURE 2

MONITORING FOR DISINFECTION BY-PRODUCTS
SYSTEM SIZE: POPULATION < 10,000
WATER SOURCE: SURFACE WATER

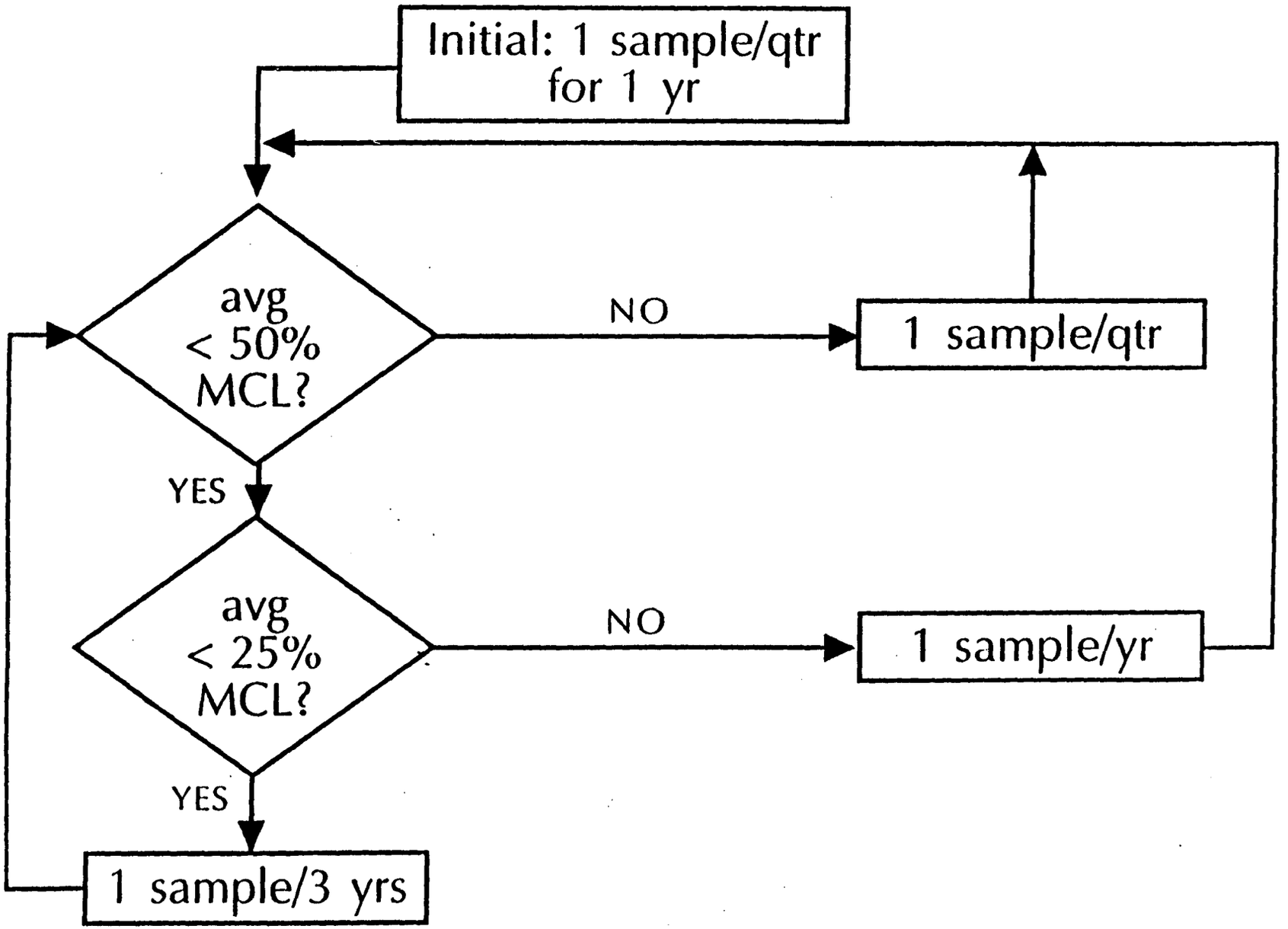
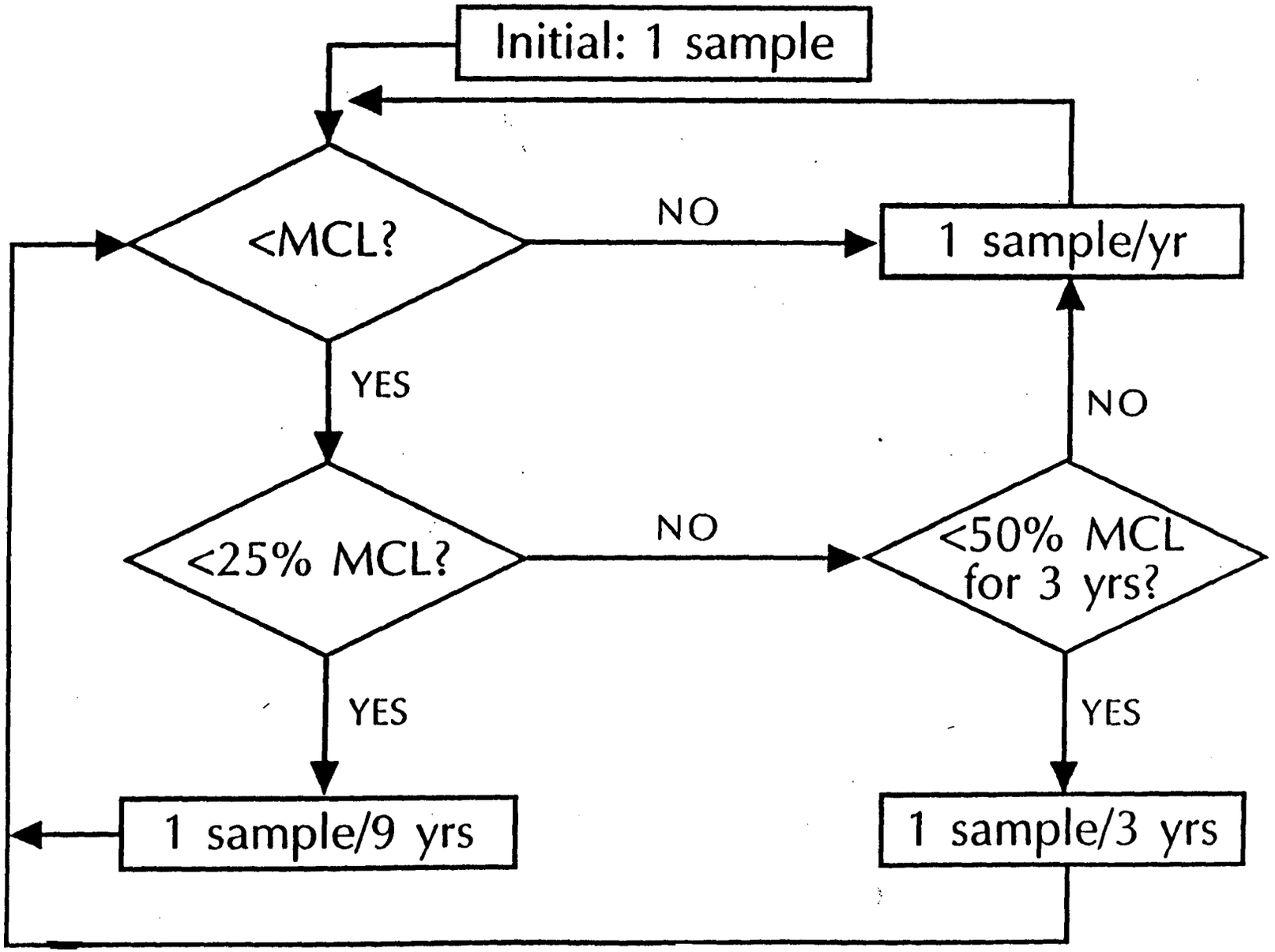


FIGURE 3

MONITORING FOR DISINFECTION BY-PRODUCTS
SYSTEM SIZE: POPULATION < 10,000
WATER SOURCE: GROUND WATER



MONITORING FOR DISINFECTANTS AND INORGANIC BY-PRODUCTS

Chlorine, chloramines, chlorine dioxide; bromate, chlorate, and chlorite (Table 5):

- Disinfectant residuals are measured at least monthly at representative locations in the distribution system under the Surface Water Treatment Rule (SWTR). The same is expected to be required under the Ground-Water Disinfection Rule (GWDR) for those systems that must disinfect distribution systems. If a system is not using a chemical disinfectant under the GWDR, then these monitoring requirements will not apply.

- Monitoring requirements for the inorganic by-products are identical to those for the disinfectants.

- Measurements of free chlorine will be required to determine compliance with the chlorine MCL; however, total chlorine measurements may be used instead. Many systems measure total chlorine residual under the SWTR.

- Total chlorine measurements will be used to determine compliance with the chloramines MCL.

- Sampling location, minimum sampling frequency, and calculations required for determining compliance with the disinfectant and inorganic by-product MCLs are specified in Table 5.

TABLE 5. MONITORING REQUIREMENTS: CHLORINE,[a] CHLORAMINES,[b] CHLORINE DIOXIDE, BROMATE, CHLORATE, AND CHLORITE

Water Source and System Size:	All vulnerable systems[c]
Sample Location:	Representative locations in the distribution system[d]
Sample Frequency:	1/month[d]
Compliance:	Annual average of monthly values must be < MCL. If more than 1 sample is taken per month, the monthly median values are averaged.

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[a]Free chlorine; analysis performed at water system. Compliance may also be determined using total chlorine measurements.

[b]Compliance determined using total chlorine measurements.

[c]To be defined.

[d]Monitoring for disinfectant residuals is already required under the SWTR and anticipated under the GWDR.

TIMING OF INITIAL MONITORING REQUIREMENTS

- The estimated dates of the disinfectant and disinfection by-product monitoring requirements and the anticipated deadlines of the GWDR are in Table 6, assuming promulgation by June 30, 1995 for both rules.

- Systems that are disinfecting at the time of promulgation will begin monitoring January 1, 1997. States will have three years to complete initial monitoring for all vulnerable systems. Systems will always have the option to begin monitoring earlier.

  Monitoring data for by-products collected up to 12 months before monitoring is required will be accepted provided treatment and source water quality have not changed.

- Three-year phase-in periods for systems that begin disinfection after 1995 will be as follows. For community water systems, initial monitoring will be phased in between January 1, 1999 and December 31, 2001. For non-transient noncommunity water systems, initial monitoring will begin January 1, 2002, which is the first January 1 after which disinfection is anticipated to be required under the GWDR.

- These monitoring requirements can accommodate any combination of regulatory MCL options. The options include, but are not limited to, setting MCLs for each contaminant, and/or MCLs for total THMs, and total haloacetic acids.

TABLE 6. TIMING OF INITIAL MONITORING REQUIREMENTS FOR DISINFECTANTS AND BY-PRODUCTS

Disinfectants/Disinfection By-Products Rule (D/DBP Rule) and Ground-Water Disinfection Rule (GWDR)

	D/DBP Rule	GWDR
Promulgation:	June 30, 1995	June 30, 1995
Effective Date:	January 1, 1997	January 1, 1997
Complete D/DBP Monitoring (Systems Currently Disinfecting):	January 1, 1997 - December 31, 1999	_____
Systems That Begin Disinfection After 1/1/95:		
Community Systems:		
Begin Disinfection:	_____	July 1, 1998
Complete D/DBP Monitoring:	January 1, 1999 - December 31, 2001	_____
Noncommunity Systems:		
Begin Disinfection:	_____	July 1, 2001
Complete D/DBP Monitoring:	January 1, 2002 - December 31, 2004	_____

COMPLIANCE DETERMINATIONS FOR BY-PRODUCTS

Under the Trihalomethane Rule of 1979, compliance is determined by comparing the running annual average of prior sample measurements to the total trihalomethane MCL. For large systems (Table 3), EPA will use the same compliance criteria for each MCL. This will apply to whatever combination of single-contaminant MCLs or group MCLs (e.g., total haloacids) that EPA adopts in the Final Rule.

This approach might discourage small systems from choosing the economy of reduced monitoring at one-, three-, and nine-year frequencies. These systems risk having compliance based on worst-case samples collected in this interval. Therefore, for systems serving less than 10,000 people, EPA will consider determining compliance for chloral hydrate, haloacids, and trihalomethanes based on a three-year forward average.

This would work as follows. A sample is collected in the first year that a system qualifies for a reduced sampling frequency. Depending on the result of this measurement, one of three repeat sampling schedules applies:

1. If the result is less than the MCL but above one or more of the trigger concentrations, the system's frequency increases as listed in Table 4.

2. If the result is less than both the MCL and the trigger concentrations, the next sample continues to be collected one, three, or nine years later.

3. If the first measurement exceeds the MCL, the system is not in violation unless the subsequent three-year average exceeds the MCL. The system must increase its monitoring to at least quarterly, and if appropriate, take corrective action to assure compliance. Under other requirements, disinfection compliance is always checked by monthly monitoring of both disinfectants and inorganic disinfection by-products--including bromate.

Request for Comments

EPA solicits public comment on these draft monitoring criteria and will consider comments in developing the Draft Rule scheduled for distribution to the public in early 1992. EPA also asks for responses to the following questions.

1. We have suggested several parameters or correlations with treatment or other by-product occurrences as ways to waive a system from some by-product monitoring.
   a. Is this a reasonable approach?
   b. What cutoffs do you suggest be set:
      i. for the indicators of source water quality listed in Table 2?
      ii. for the reduced monitoring trigger concentrations in Tables 3 and 4?
   c. Do you have data to support other indicators?
   d. Because of expense and complexity, we have not proposed simulated distribution system formation studies. Should we offer this option? If so, how can it be cost-effective?

2. For large systems, the proposed monitoring requirements for all by-products are identical to the requirements of the 1979 THM Rule.
   a. Is this reasonable?
   b. Or should EPA allow more flexibility in both initial and repeat monitoring? Specifically,
      i. for initial monitoring, should we permit a range of 2-4 samples per quarter rather than requiring 4 per quarter?
      ii. for repeat or reduced monitoring, should EPA allow less frequent monitoring when a system is reliably and consistently below some percentage of the MCL? For example, if for three years a system is below a trigger percentage of the MCL, the sampling frequency could be reduced to once every three years.

3. When less than four samples per sampling period are collected, or when the sampling frequency is less than quarterly, we require that compliance with an MCL be based on a worst-case sample.
   a. Is it cost-effective for a system to select such a site and time?
   b. Should we only permit less than two samples and less than quarterly monitoring at very small systems?
   c. If so, should these be defined only as: serving a population less than 3,300? less than 500? or non-transient noncommunity systems?
   d. Should EPA not permit less than one sample per year per system under any conditions?

4. If EPA fully adopted the Standardized Monitoring Framework nine-year compliance cycle, initial monitoring for systems that currently disinfect and for community water systems that begin disinfection under the GWDR would be between 1999-2001. This is a two-year delay for systems now disinfecting; no delay for the others. Non-transient noncommunity systems would begin disinfection in July 2001. This means initial monitoring would run from 2002 to 2004. This represents no delay if the GWDR criteria are in effect before Dec. 31, 2001.

   Under what circumstances should EPA conform to the Framework's nine-year compliance cycles, given that this gives systems the option to delay monitoring two years after an MCL becomes effective?

5. For small systems, we have suggested three-year forward-averaging periods for compliance with MCLs for trihalomethanes, haloacetic acids, and chloral hydrate. This is done to help systems that collect worst-case samples on a frequency that is less than quarterly.
   a. Do you agree with this approach?
   b. Should EPA allow three-year averaging only for some by-products, and require one-year averaging for by-products that have MCLs set at the high end of the relative risk range?

6. Compliance determinations have not been thoroughly discussed in this draft. Do you have suggestions for determining compliance when worst-case samples are collected, or when sampling frequencies are less than quarterly?

=== END ===