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Part II

Environmental Protection Agency

40 CFR Parts 141 and 142

Drinking Water; National Primary Drinking Water Regulations; Filtration, Disinfection; Turbidity, Giardia lamblia, Viruses, Legionella, and Heterotrophic Bacteria; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 141 and 142

[WH-FRL-3607-7]

Drinking Water; National Primary Drinking Water Regulations; Filtration, Disinfection; Turbidity, Giardia lamblia, Viruses, Legionella, and Heterotrophic Bacteria

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: This notice, issued under the Safe Drinking Water Act, publishes maximum contaminant level goals for *Giardia lamblia* viruses, and *Legionella;* and promulgates national primary drinking water regulations for public water systems using surface water sources or ground water sources under the direct influence of surface water that include (1) criteria under which filtration (including coagulation and sedimentation, as appropriate) are required and procedures by which the States are to determine which systems must install filtration, and (2) disinfection requirements. The filtration and disinfection requirements are treatment technique requirements to protect against the potential adverse health effects of exposure to *Giardia lamblia,* viruses, *Legionella,* and heterotrophic bacteria, as well as many other pathogenic organisms that are removed by these treatment techniques. This notice also includes certain limits on turbidity as criteria for (1) determining whether a public water system is required to filter; and (2) determining whether filtration, if required, is adequate.

DATES: This regulation is effective December 31, 1990. The incorporation by reference of certain publications listed in the rule is approved by the Director of the Federal Register as of December 31, 1990.

ADDRESSES: A copy of the public record for this rulemaking, including public comments on the rule and supporting documents, is available for review at the EPA Drinking Water Docket, Room EB15, 401 M Street, SW., Washington, DC 20460. For access to the docket materials, call (202) 382–3027 between 9 a.m. and 3:30 p.m. Major supporting documents cited in the reference section of this notice are available for inspection at the Drinking Water Supply Branches in EPA's Regional Offices, listed below.

I. JFK Federal Bldg., Room 2203, Boston, MA 02203, Phone: (617) 565–3610, Jerome Healey
II. 26 Federal Plaza, Room 824, New York, NY 10278, Phone: (212) 264–1800, Walter Andrews
III. 841 Chestnut Street, Philadelphia, PA 19107, Phone: (215) 597–9873, Jon Capacasa
IV. 345 Courtland Street, Atlanta, GA 30365, Phone: (404) 347–2913, Michael Leonard
V. 230 S. Dearborn Street, Chicago, IL 60604, Phone: (312) 353–2650, Joseph Harrison
VI. 1445 Ross Avenue, Dallas, TX 75202, Phone: (214) 655–7155, Thomas Love
VII. 726 Minnesota Avenue, Kansas City, KS 66101, Phone: (913) 236–2815, Ralph Langemeier
VIII. One Denver Place, 999 18th Street, Suite 1300, Denver, CO 80202–2413, Phone: (303) 293–1424, Marc Alston
IX. 215 Fremont Street, San Francisco, CA 94105, Phone: (415) 974–0763, William Thurston
X. 1200 Sixth Avenue, Seattle, WA 98101, Phone: (206) 442–1225, Richard Thiel

Copies of the latest draft Guidance Manual for Compliance with the Surface Water Treatment Requirements for Public Water Systems ("Guidance Manual"), Regulatory Impact Analysis: Benefits and Costs of the Final Surface Water Treatment Rule, Health Advisory for *Legionella,* Technology and Costs for the Treatment of Microbial Contaminants in Potable Water Supplies, and health criteria documents for *Giardia lamblia,* viruses, *Legionella,* and turbidity are available for a fee from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. The toll-free number is (800) 336–4700; the local number is (703) 487–4650.

FOR FURTHER INFORMATION CONTACT: The Safe Drinking Water Hotline, telephone (800) 426–4791 (except Alaska) or (202) 382–5533 in the Washington, DC metropolitan area or Alaska, or Stig Regli, Environmental Engineer, Science and Technology Branch, Criteria and Standards Division, Office of Drinking Water (WH–550D), Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, telephone (202) 382–7379.

SUPPLEMENTARY INFORMATION:

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Abbreviations Used In This Notice

CFR: Code of Federal Regulations
CWS: Community Water System
CT: Residual Disinfectant Concentration in mg/l ("C") × Disinfectant Contact Time in min ("T")
CTcalc: Calculated CT Value
$CT_{99.9}$: CT Value Necessary to Achieve 99.9 Percent Inactivation
EPA: Environmental Protection Agency
HPC: Heterotrophic Plate Count
MCL: Maximum Contaminant Level
MCLG: Maximum Contaminant Level Goal
NIPDWR: National Interim Primary Drinking Water Regulation
NPDWR: National Primary Drinking Water Regulation
NTU Nephelometric Turbidity Unit
PWS: Public Water System
RIA: Regulatory Impact Analysis
RMCL: Recommended Maximum Contaminant Level
SDWA or "The Act": Safe Drinking Water Act, as amended in 1986

I. Legal Authority

EPA is promulgating this regulation under the authority of Secs. 1401, 1412, 1413, 1414, 1415, 1416, 1445, and 1450 of the Safe Drinking Water Act, as amended. 42 U.S.C. 300f, 300g–1, 300g–2, 300g–3, 300g–4, 300g–5, 300j–4, and 300j–9.

II. Background

A. Statutory Requirements

The 1986 amendments to the Safe Drinking Water Act ("SDWA" or "the Act"), Pub. L. 99–339, require EPA to promulgate a national primary drinking water regulation (NPDWR) specifying criteria under which "filtration" (defined in section 1412(b)(7)(C)(i) as including pretreatment measures such as coagulation and sedimentation, as appropriate) is required as a treatment technique for public water systems supplied by surface water sources. In establishing these criteria, EPA must consider source water quality, protection afforded by watershed management, treatment practices such as disinfection and length of water storage, and other factors relevant to protection of health.

In lieu of provisions for obtaining a variance from the filtration requirements under section 1415 of the Act, EPA must instead specify procedures which the State is to use to determine which public systems must use filtration based on the criteria that EPA establishes in this regulation.

Note: Throughout this preamble, the term "State" is used to mean a State with primary enforcement responsibility for public water systems or "primacy," and to mean EPA in the case of a State that has not obtained primacy.

States may require the public water system to provide studies or other information to assist in this determination. The procedures for determining whether filtration is required must provide notice and opportunity for public hearing.

EPA was to promulgate this NPDWR by December 19, 1987. In March 1988, the Bull Run Coalition in Portland, Oregon sued the Agency for failure to issue the rule by the statutory deadline. On January 17, 1989, a consent decree committing EPA to promulgate this rule by June 19, 1989 was filed in the District Court of Oregon.

Within 18 months after EPA promulgates the NPDWR specifying filtration requirements, a State with primary enforcement responsibility for public water systems must adopt any regulations necessary to implement the requirements of this NPDWR. Within 12 months of the adoption of such regulations, the State must make determinations regarding filtration for all public water systems supplied by surface waters within its jurisdiction. If the State determines that filtration by a public water system is required, the State must prescribe a schedule for that system that requires compliance within 18 months of the determination.

The 1986 amendments to the Safe Drinking Water Act also required EPA, by June 19, 1989, to: (1) Promulgate a NPDWR requiring disinfection as a treatment technique for all public water systems (including those served by surface water and those served by ground water) and a rule specifying criteria by which variances to this requirement may be granted; and (2) publish maximum contaminant level goals and promulgate NPDWRs for 83 contaminants listed in the Advance Notices of Proposed Rulemaking published at 47 FR 9352 (March 4, 1982) and 48 FR 45502 (October 5, 1983). This list of contaminants includes turbidity and five microbiological contaminants: *Giardia lamblia* ("*Giardia*"), viruses, *Legionella*, Heterotrophic Plate Count bacteria ("heterotrophic bacteria" or "HPC"), and total coliforms.

B. Regulatory History

In the Advance Notice of Proposed Rulemaking published on October 5, 1983, EPA discussed issues pertaining to regulation of turbidity, *Giardia lamblia*, viruses, *Legionella*, and HPC, as well as filtration treatment for surface water and disinfection requirements for all systems (48 FR 45502). On November 13, 1985, EPA proposed MCLGs for turbidity, *Giardia lamblia*, and viruses and solicited comment on the appropriateness of establishing MCLGs and NPDWRs for *Legionella* and HPC (50 FR 46936). (In this rule "viruses" means viruses of fecal origin which are infectious to humans by waterborne transmission. "*Legionella*" means a genus of bacteria, some species of which have caused a type of pneumonia called Legionnaires disease; the etiologic agent of most cases of Legionnaires disease examined has been *L. pneumophila*.) Public comments on these two **Federal Register** notices and EPA's responses to the comments are included in the Response to Comments document in the public docket for this rulemaking (USEPA, 1989d).

On November 3, 1987, EPA: (1) Reproposed MCLGs for *Giardia lamblia* and viruses, and proposed an MCLG for *Legionella*; (2) proposed a national primary drinking water regulation specifying (a) criteria under which filtration (including coagulation and sedimentation, as appropriate) is required as a treatment technique for public water systems using surface water sources and procedures by which the State must determine which systems must install filtration and (b) disinfection treatment technique requirements for public water systems using surface water sources (52 FR 42178). The proposed filtration and disinfection requirements were intended to protect against the potential adverse health effects of exposure to *Giardia lamblia*, viruses, *Legionella*, and heterotrophic bacteria, as well as many other pathogenic organisms that are removed by these treatment techniques. The November 3, 1987, notice also withdrew the November 13, 1985, proposed MCLG for turbidity and proposed certain limits on turbidity as criteria for: (1) Determining whether a public water system is required to filter; and (2) determining whether filtration, if required, is adequate.

On January 7, 1988, EPA published a notice extending the public comment period on these proposed surface water treatment requirements (53 FR 1392). On

May 6, 1988, EPA published a Notice of Availability which solicited specific data, discussed alternatives to the proposed surface water treatment requirements and solicited comment on these alternative options, and designated July 5, 1988, as the end of the public comment period (53 FR 16348).

C. Regulatory Framework

As explained in greater detail in the proposal, this rule fulfills the following statutory requirements:

(1) The requirement that EPA promulgate a NPDWR specifying criteria under which filtration (including coagulation and sedimentation, as appropriate) is required as a treatment technique for public water systems using surface water sources, including procedures by which the State will determine which systems must install filtration. *See* section 1412(b)(7)(C).

(2) The requirement that EPA promulgate a NPDWR requiring disinfection as a treatment technique for public water systems using surface water sources (EPA intends to promulgate additional regulations specifying disinfection requirements for systems using ground water sources at a later date). *See* section 1412(b)(8).

(3) The requirement that EPA regulate *Giardia lamblia*, viruses, *Legionella*, heterotrophic plate count bacteria, and turbidity. *See* section 1412(b)(1). (Coliforms are regulated in a separate rule published elsewhere in today's **Federal Register**.)

(a) *Giardia lamblia* cysts pose significant risks to health for systems using surface waters, but usually not for systems using ground water, because these protozoan cysts are removed from water by natural filtration processes in the course of the water's passage through the ground. The turbidity level, which is a measure of particulate matter in water, is an indicator of the effectiveness of treatment processes that control pathogens, including *Giardia*, in systems using surface water. Turbidity is not a useful indicator of treatment effectiveness for most ground water systems since most particulates are already being removed by natural filtration processes in the course of the water's passage through the ground. Because natural filtration processes remove turbidity and *Giardia* from ground water, EPA believes that promulgation of this regulation, which applies to public water systems using surface water sources (or, as explained later, ground water sources under the direct influence of surface water) and includes turbidity requirements, is adequate to control these contaminants, so additional NPDWRs to regulate *Giardia* and turbidity in ground water are unnecessary. Thus, it is EPA's position that today's regulation fulfills the SDWA requirement to regulate *Giardia lamblia* and turbidity.

(b) This rule also provides protection from viruses, *Legionella*, and HPC in surface water and thereby complies with the SDWA requirement to regulate these contaminants in surface water systems. EPA intends to promulgate NPDWRs to control the levels of viruses, *Legionella*, and HPC in drinking water derived from ground water sources. These regulations will be included in the disinfection requirements for ground water sources.

The criteria in this final rule are designed to control microbiological contamination in general, not just *Giardia lamblia*, viruses, *Legionella*, and HPC. Since no waterborne disease outbreaks have been identified in properly designed, well-operated systems, i.e., systems that meet these criteria, EPA believes that compliance with this rule will provide significant protection from most waterborne pathogens, including those not specifically covered by this rule. For instance, EPA believes that filtered systems which comply with the requirements of this rule for such systems will provide significant protection from *Cryptosporidium*, a protozoan recently implicated in waterborne disease outbreaks. However, because of the current uncertainty of the effectiveness of disinfection for inactivating *Cryptosporidium*, the degree of protection from this protozoan for systems which choose to comply with the requirements of this rule for unfiltered systems may be more limited. EPA is currently conducting studies to determine whether additional regulations may be necessary to control for *Cryptosporidium*.

III. Response to Major Issues

In this section, EPA describes the major comments it received on the proposed criteria, which provisions of the final rule have been changed in response to those comments, and the rationale for those changes. EPA's more detailed responses to the public comments appear in the Response to Comments document in the public docket. (USEPA, 1989b.) This section is presented prior to the description of the final rule (Section IV) and assumes the reader is familiar with the proposed rule. Therefore, depending on interest and background, the reader may prefer to either skip this section or read Section IV first.

A. Determination of Source Water Type

Under the proposed rule, "surface water" was defined as

> All water (1) open to the atmosphere and subject to surface runoff, or (2) which is directly influenced by surface water, as defined in (1), which may include springs, infiltration galleries, or wells. Whether there is direct influence by surface water must be determined on a case-by-case basis. Direct influence may be indicated by: (i) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH (which may also change in ground water but at a much slower rate) which closely correlate to climatologic or surface water conditions, or (ii) the presence of insects or other macroorganisms, algae, organic debris, or large-diameter pathogens such as *Giardia lamblia*.

Some commenters supported the definition because it would allow States to require treatment to control for *Giardia* cysts, if such contamination were apparent, in systems using sources traditionally classified as ground water. Other commenters objected to the definition because it included aquifers, depending upon how the term "direct influence by surface water" was interpreted. Aquifers, for the most part, are protected from contaminants, such as *Giardia* cysts, which are characteristic of surface water supplies; thus, they argue, it is not necessary to subject these systems to this rule. Many commenters were concerned that the proposed definition would require States to evaluate all ground water systems to determine whether they were under the direct influence of surface water within 30 months following the promulgation of the rule. Commenters considered this impractical because of the limited resources available to States.

EPA agrees that most systems using sources traditionally defined as ground water are not at risk from contamination by *Giardia* cysts or other contaminants typically found in surface water. The rate of reported waterborne outbreaks of giardiasis in systems using ground water (as traditionally defined, i.e., water not open to the atmosphere) is about 1/43 of that in filtered and disinfected surface water supplies and about 1/326 of that in unfiltered surface water supplies (Craun, 1989). However, *Giardia* cysts do occur in some ground water supplies due to contamination by surface water (e.g., springs, infiltration galleries, and wells; Hibler, 1987a). Therefore, EPA believes it is appropriate that all ground water systems be evaluated, on a case-by-case basis, for the potential of contamination by *Giardia* cysts. EPA believes that a system at significant risk from

contamination of *Giardia* cysts, i.e., a ground water system under the direct influence of surface water where the structure of the system cannot be altered to reduce this risk, should be required to comply with the treatment requirements of this rule to ensure adequate protection of public health.

Based on information provided in public comments and further consideration, EPA agrees that the statutory timeframe for States to make filtration decisions (i.e., 30 months from promulgation of this rule) does not provide adequate time for States to evaluate which ground water systems are under the direct influence of surface water. In addition, EPA believes the most practical approach for States is to make these determinations when sanitary surveys are conducted pursuant to the NPDWR for total coliforms (published elsewhere in today's **Federal Register**) and/or when ground water systems are evaluated for adequacy of treatment under the forthcoming disinfection requirements for ground water systems.

EPA is also concerned that if a system using a ground water source were reclassified as a "surface water source" because the State determines it is under the direct influence of surface water, as described in the proposal, such a system also would be required to comply with other regulations pertaining to surface water supplies (e.g., under other NPDWRs, surface water supplies have different monitoring requirements than ground water supplies). This may or may not be appropriate, depending upon the characteristics of the system.

EPA has addressed the above concerns by making the following changes in the final rule:

a. The definition of surface water has been shortened to "all water open to the atmosphere and subject to surface runoff."

b. The final rule defines a new term, "ground water under direct influence of surface water," as:

> Any water beneath the surface of the ground with (i) significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*, or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources in accordance with criteria established by the State. The State determination of direct influence may be based on an evaluation of site-specific measurements of water quality and/or well construction characteristics and geology with field evaluation.

c. When the State revises its drinking water regulations to adopt today's rule, the revisions must include a program for determining which systems using ground water as a source are under the direct influence of surface water (i) within 5 years following the promulgation date of this rule for community water systems, and (ii) within 10 years following the promulgation date of this rule for non-community water systems. These timeframes are consistent with the schedule for conducting sanitary surveys under the total coliform rule, promulgated elsewhere in today's **Federal Register**. EPA believes these time frames are reasonable because the sanitary surveys will provide much of the information necessary to make the determination.

d. All unfiltered ground water systems that the State determines are under the direct influence of surface water must (i) begin monitoring 6 months following the determination to demonstrate they are meeting the criteria to avoid filtration and comply with the requirements for avoiding filtration beginning 18 months following the determination, unless the State determines that filtration is required, or (ii) install filtration and comply with the monitoring and treatment requirements for filtered systems beginning 18 months following the determination that filtration is required. This schedule is explained in more detail in the section entitled "Compliance," below.

Guidance for evaluating whether ground water systems are under the direct influence of surface water will be available in the final Guidance Manual. EPA recommends that infiltration galleries, springs, and shallow wells be evaluated first, then, depending upon aquifer characteristics, wells in increasing depth. EPA believes that, for most ground water systems, only minimal analysis will be necessary to make this determination. Simply put, if a ground water system is subject to *Giardia* contamination (unless the contamination originates within the distribution system), States should classify it as a source under the direct influence of surface water and thus subject to the treatment requirements of this rule. It is important to note that the intent of this rule is not to regulate viral and bacterial contamination in systems using ground water, unless *Giardia* cysts are also associated with such occurrence. Thus, if there is little likelihood for *Giardia* cysts to occur in a system using ground water, but there is potential for bacterial and viral contamination, EPA does not expect the State to classify this source as a ground water source under the direct influence of surface water. Compliance with the NPDWR for total coliforms (published elsewhere in today's **Federal Register**) and/or the forthcoming disinfection requirements for disinfection of ground water systems will require adequate treatment to address these other concerns.

EPA anticipates that while some ground water systems, such as infiltration galleries, springs, and shallow wells, may be under direct influence of surface water in their current configuration, in many cases, it may be possible to make structural modifications to prevent the direct influence of surface water and eliminate the potential for *Giardia* cyst contamination, thereby avoiding the requirements of this rule.

Note: Throughout the remainder of this preamble, unless otherwise noted, we use the term "surface water systems" and related terms to include both public water systems using a surface water source and public water systems using a ground water source under the direct influence of surface water.

B. 99.9 Percent Removal and/or Inactivation of Giardia Cysts

EPA proposed to require all systems using surface water to achieve at least a 99.9 percent (3-log) removal and/or inactivation of *Giardia lamblia* cysts. Many commenters thought it inappropriate to require the same minimum percent removal requirement for all systems, regardless of differences in source water quality and potential risk. Several commenters suggested that EPA allow exceptions to this minimum treatment performance requirement based on source water quality (e.g., low occurrence of *Giardia* cysts) and/or epidemiological evidence of low risk. Some commenters thought that EPA should base the treatment requirement upon some level of acceptable risk in the finished water.

EPA continues to support the rationale presented in the preamble to the proposed rule for setting the minimum performance criteria of 99.9 percent removal and/or inactivation of *Giardia* cysts (52 FR 42194–42195). Furthermore, additional information has become available to support these criteria.

Table III.1 indicates peak and average *Giardia* cyst concentrations in polluted and pristine source waters of public drinking water supplies (Rose, 1988), where waters contaminated with sewage and agricultural wastes were characterized as "polluted" and waters originating from protected watersheds with no significant sources of microbiological contamination from human activities were classified as "pristine." The indicated concentration

levels reflect actual counts of cysts detected without adjustment for inefficiencies in recovery (recovery efficiencies were unknown for most samples). These data indicate that, even though average cyst concentrations can be significantly higher in polluted than in pristine source waters, at least part of the year peak cyst concentration levels in pristine waters can be the same order of magnitude as the levels in polluted supplies. Occasional high concentrations of *Giardia* cysts in source waters with protected watersheds may occur due to contamination from animal populations. Thus, during the part of the year when the water is most contaminated, i.e., the concentrations of *Giardia* are the highest, approximately the same level of treatment performance is necessary for a pristine water source as is necessary for a polluted source to provide the same level of protection.

TABLE III.1—GIARDIA CYST DENSITIES IN SOURCES OF DRINKING WATER [1]

Type of water	Number of samples	Number of sites	Percent [2] positive for Giardia	Cysts/100 liters		
				Peak	Range of mean concentrations [3]	Mean of all concentrations [3]
Waters polluted with human and agricultural wastes	135	8	43	625	0.33–104	33
Pristine waters	283	7	10	114	0.6–5	0.9
Waters of unknown quality	1,226	18	26.4	100	0.005–2.95	0.61

[1] Rose, 1988.
[2] Percent of the samples.
[3] Geometric mean.

To date, in each reported waterborne disease outbreak of giardiasis, at least 0.5 percent or greater of the population (50 or more per 10,000 people or 5×10^{-3}) were infected (Rose, 1988). EPA believes that public water supplies should provide much greater protection than simply that necessary to avoid this level of risk from waterborne disease. EPA believes that providing treatment to ensure less than one case of microbiologically caused illness per year per 10,000 people is a reasonable goal. This is comparable to other acceptable microbiological risk levels (Regli et al., 1988).

Based on a recent risk analysis, which assumes all cysts found are viable and infectious to humans, the incidence of infection from *Giardia* was predicted as a function of exposure to cyst concentrations in drinking water (Rose, 1988). Tables III.2 and III.3 indicate the daily and annual risk from *Giardia* infection for people consuming finished water with different *Giardia* cyst concentrations. The tables also specify the level of treatment (i.e., 3-, 4- or 5-log removal and/or inactivation of *Giardia* cysts) needed for source water with different cyst concentrations to ensure that the indicated daily and annual risk per person are not exceeded.

Comparing Table III.2 with Table III.1, it appears that water treatment plants which provide 3-log removal and/or inactivation of *Giardia* cysts would generally ensure exposure to risk of giardiasis of less than 10^{-4} (i.e., less than one in 10,000 people infected) during days of worst case *Giardia* cyst occurrence (defined as 250 cysts/100 liters). Comparing Table III.3 with Table III.1, it appears that water treatment plants which provide 3- to 5-log removal and/or inactivation of *Giardia* cysts, depending on source water quality (e.g., for waters with less than 0.7 cysts/100 liters and 3-log removal and/or inactivation, or water with less than 70 cysts/100 liters and 5-log removal and/or inactivation), would generally ensure that the risk of giardiasis is less than 10^{-4} per year. Although EPA recognizes that the above analysis may be conservative, it is not unreasonable since the cyst occurrence levels, as indicated in Table III.1, may actually be much higher due to poor efficiencies of recovery. EPA believes that 3- to 5-log removal and/or inactivation of *Giardia* cysts represents a reasonable level of protection for the range of source water contamination expected to occur in the United States. Therefore, the final rule requires that all systems achieve at least a 3-log removal and/or inactivation of *Giardia* cysts. In the final Guidance Manual, EPA will recommend specific minimum performance levels in the 3- to 5-log range, depending upon the expected degree of cyst contamination in the source water.

TABLE III.2—ESTIMATED DAILY RISK OF GIARDIA INFECTIONS FROM VARIOUS LEVELS OF CYST CONTAMINATION IN DRINKING WATER USING AN EXPONENTIAL RISK ASSESSMENT MODEL [1]

Daily risk per person [2]	Cyst concentration in 100 liters of finished water	Allowable Cyst concentration in 100 liters of source water to achieve given treatment reductions		
		3=log	4=log	5=log
$10^{-3.5}$	[3] 0.75	7.5×10^{2}	7.5×10^{3}	7.5×10^{4}
10^{-4}	0.25	2.5×10^{2}	2.5×10^{3}	2.5×10^{4}
$10^{-4.5}$	0.075	75	7.5×10^{2}	7.5×10^{3}
10^{-5}	0.025	25	2.5×10^{2}	2.5×10^{3}

[1] Rose, 1988.
[2] Assumes 2 liters of water consumed per day.
[3] Level of cysts detected during waterborne outbreaks of giardiasis.

TABLE III.3—ESTIMATED ANNUAL RISK OF GIARDIA INFECTIONS FROM VARIOUS LEVELS OF CYST CONTAMINATION IN DRINKING WATER USING AN EXPONENTIAL RISK ASSESSMENT MODEL [1]

Annual risk per person [2]	Geometric mean cyst concentration in 100 liters of finished water for one year	Allowable Cyst concentration in 100 liters of source water to achieve given treatment reductions		
		3=log	4=log	5=log
$10^{-3.5}$	2×10^{-3}	2.0	20	200
10^{-4}	7×10^{-4}	0.7	7.0	70
$10^{-4.5}$	2×10^{-4}	0.2	2.0	20
10^{-5}	7×10^{-5}	0.07	0.7	7.0

[1] Rose, 1988.
[2] Assumes 2 liters of water consumed per day.

The treatment performance levels cited above are consistent with what is currently being achieved by well-operated systems in the U.S. Figures III.1 and III.2 illustrate levels of *Giardia* cyst inactivation achieved by disinfection alone during winter and summer months, respectively, by typical filtered water supplies in the U.S. (based on data from AWWA (1987)). Assuming a 2- to 3-log removal of *Giardia* cysts by conventional treatment (which is used by most of the utilities represented in Figures III.1 and III.2) without disinfection, a total of at least 3- to 5-log removal and/or inactivation of *Giardia* cysts from filtration and disinfection combined is generally achieved in well-operated water treatment plants in the U.S.

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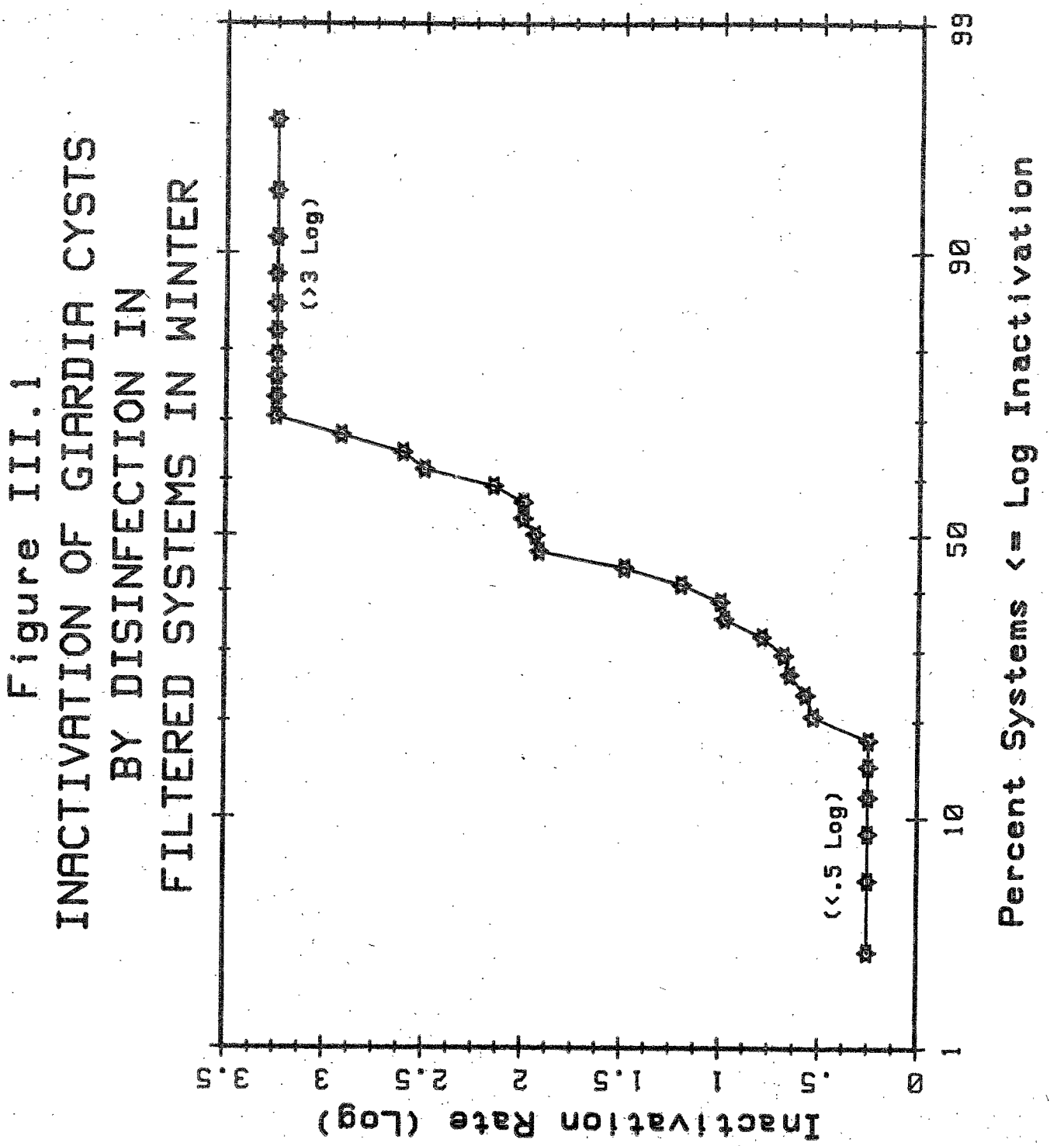
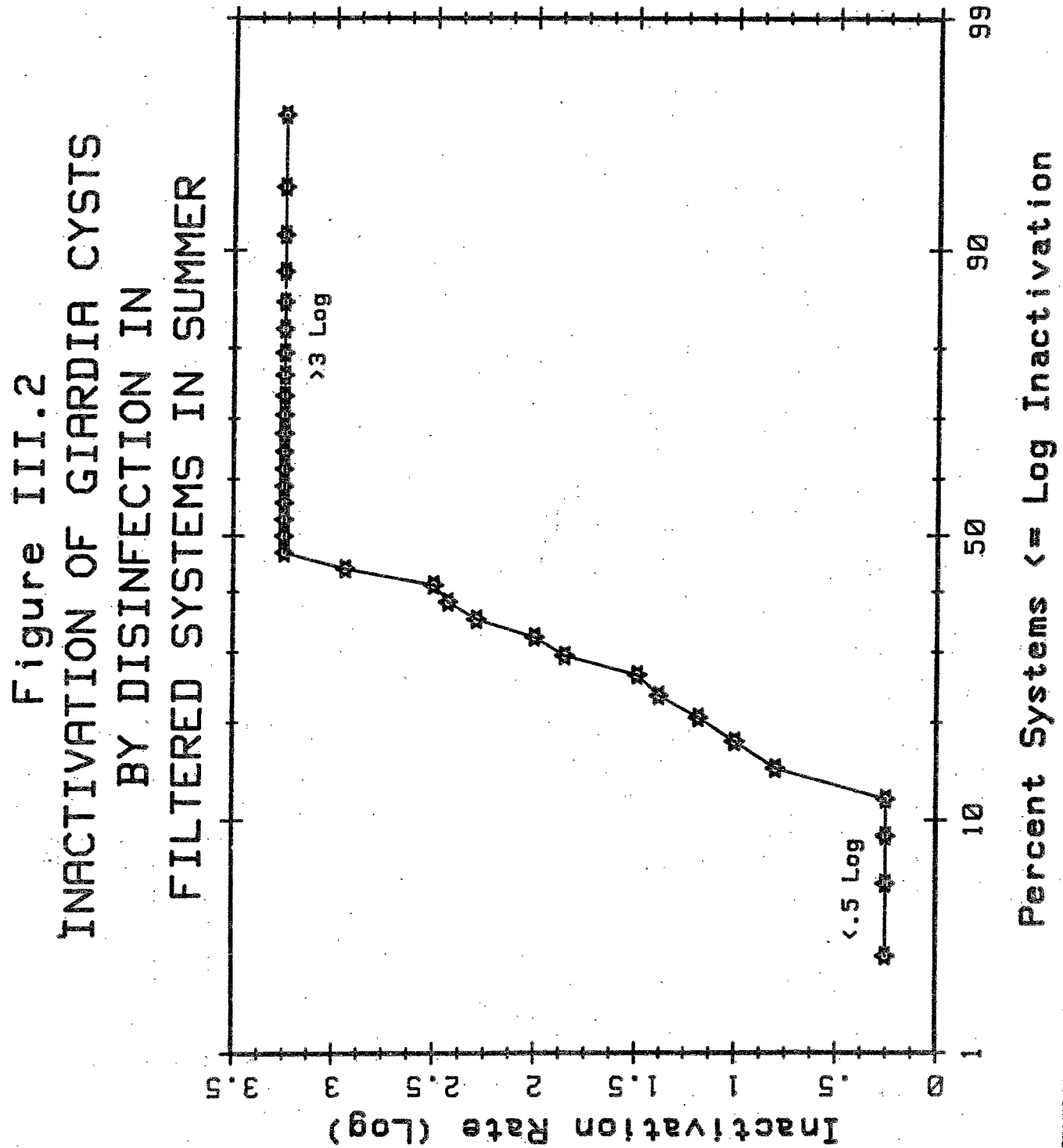


Figure III.1
INACTIVATION OF GIARDIA CYSTS
BY DISINFECTION IN
FILTERED SYSTEMS IN WINTER
(>3 Log)
(<.5 Log)
Inactivation Rate (Log)
0
.5
1
1.5
2
2.5
3
3.5
Percent Systems <= Log Inactivation
1
10
50
90
99



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EPA believes it is inappropriate for the rule to specify different levels of treatment for different source water qualities because it is generally not feasible to confidently quantify *Giardia* cyst concentrations. As explained in the proposal, there is no analytical method for measuring *Giardia lamblia* cysts for which the precision, efficiency, and sensitivity have been adequately defined; no reliable validation procedures or laboratory certification procedures are available; and very large numbers of samples would be needed to accurately quantify levels of cyst occurrence.

Although some systems might not actually need a 3-log removal and/or inactivation of *Giardia* cysts to provide adequately safe water to their customers, EPA believes it is not feasible for a system to demonstrate with assurance, e.g., with water quality monitoring results, that lower removals and/or inactivations would be adequately protective of public health. Nor is the historical absence of a waterborne disease outbreak a sufficiently sensitive indicator that adequate treatment is in place. For example, assuming that at least 0.5 percent of the population must become ill within less than one month to detect an outbreak, the ongoing absence of an outbreak simply indicates that fewer than 5 people per thousand become ill during any month. EPA also believes that generally it cannot be demonstrated with confidence that low levels of waterborne illness (e.g., less than one in 10,000 people per year) are being avoided based on epidemiological analysis of reported illnesses to the medical community, since only illnesses with a significant adverse symptomatic response tend to be reported and such reports only represent levels of illness among non-transient populations. Also, levels of illness may vary significantly from year to year depending on the level of contamination and variations in pathogen strains which might occur in the source water, and the level of treatment provided. Therefore, to assure that adequate protection will be provided, the final rule does not allow systems to achieve less than a 3-log removal and/or inactivation of *Giardia* cysts.

C. Continuous Disinfection at the Entry Point to the Distribution System

EPA proposed to require that all systems using surface water (both unfiltered and filtered) disinfect their water and continuously monitor the disinfectant residual entering the distribution system. Under the proposal, each system would record the lowest disinfectant residual concentration entering the system each day. Any time the residual was less than 0.2 mg/1, the system would be in violation of a treatment technique requirement. This violation would be considered "acute," thus requiring the system, under the public notification requirements in 40 CFR 141.32, to notify the public of the violation within 72 hours via electronic media, as well as provide subsequent written notice, if it were a community water system; non-community water systems could substitute posting or hand delivery of notices. In response to this proposed requirement, EPA received the following comments:

- The short-term absence of a disinfectant residual at the entry point to the distribution system should not automatically trigger immediate public notification since the actual health risks, depending upon site-specific circumstances, may not be significant.
- Continuous monitoring equipment is subject to failure; such failures are generally beyond the control of the operator. Thus, such failure should not be classified as either a monitoring violation or a treatment technique violation.
- Continuous monitoring is unnecessary to demonstrate effective ongoing disinfection and it will not result in any increased health benefit. Grab sample monitoring every four hours is sufficient for large systems; one sample per day is adequate and reasonable for small systems.
- The cost for very small systems to install continuous monitoring equipment is excessive (cited as about $5,000 for one analyzer and continuous recorder or $10,000 with another unit as a backup) and maintenance would be difficult.

In response to the comments on the proposal, in the May 6, 1988, notice of availability, EPA solicited comments on various options for revising the continuous disinfection requirement. Most commenters addressing these options supported the changes. Based on these comments, and the reasons explained below, EPA has modified the proposed disinfection requirements in the final rule as follows:

- If the residual is less than 0.2 mg/l for any period of time, the system must notify the State as soon as possible but no later than by the end of the next business day after it is first detected.
- If the residual measured is less than 0.2 mg/l and it has not been restored to 0.2 mg/l or higher within four hours of the first measurement, then the system is in violation of a treatment technique requirement. Under the final rule, this violation is a Tier 1 violation (see the public notification rules at 40 CFR 141.32) but is not defined as posing an "acute" health risk, so immediate public notification by electronic media, posting, or hand delivery (depending on system type) is not required unless the State determines it is appropriate.
- If there is a failure in continuous monitoring equipment, grab sampling every four hours may be conducted for up to five working days following the failure of the equipment. Failure to use continuous monitoring equipment after the five days have passed is a monitoring violation.
- Systems serving 3,300 people or fewer may take grab samples, at the frequencies described below, in lieu of performing continuous monitoring.

System size by population	Samples/day [1]
≤500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

[1] The day's samples cannot be taken at the same time. The sampling intervals are subject to State review and approval.

Note: If the residual is less than 0.2 mg/l in any sample, the system must take another grab sample within four hours of the first sample. If the residual has not been restored to 0.2 mg/l or higher, the system must continue to sample at least every four hours until the residual is restored to 0.2 mg/l or higher.

EPA believes the revised criteria will prevent unnecessary public notification. The Agency recognizes that some systems may have very clean source water and/or achieve excellent microbiological removal by filtration and other treatment processes, without always maintaining a disinfectant residual of 0.2 mg/l or higher. Some systems that experience a brief reduction in their disinfection process, depending on source water quality and whether other treatment processes are in place, may expose the population to significant health risk while others may not. Thus, EPA agrees that it is inappropriate to categorically define a short-term reduction in the disinfection residual as a violation which poses an "acute" health risk, thus requiring immediate public notification via electronic media, posting, or hand delivery (depending on system type). Instead, EPA believes that States should make these determinations as appropriate. Similarly, since all systems are prone to operational failure at some time, but not all such situations pose a significant health risk, EPA believes that some time interval should be allowed

for systems to restore the disinfectant residual rather than categorically defining this absence as a treatment technique violation. EPA believes that once the system becomes aware that the disinfectant concentration level is low or absent, four hours is a reasonable maximum time interval for operators to adjust and/or repair the disinfection or monitoring equipment or to bring backup disinfection or monitoring units on-line.

EPA agrees with the commenters that, for some small systems, it may not be practical to keep monitoring units in continuous operation. Therefore, in the final rule, EPA is allowing grab sampling for small systems. EPA believes that requiring a minimum of one grab sample daily will ensure that the operator checks on the disinfection process at least once a day.

In the May 6, 1988, notice, EPA suggested that grab sample monitoring once per day be allowed for systems serving 500 people or fewer; EPA also solicited comment on whether grab sampling should be allowed for some larger systems as well. Several commenters suggested that the rule allow grab sampling for systems serving fewer than 3,300 people, but at higher frequencies than required for systems serving fewer than 500 people. EPA considers this suggestion reasonable and has modified the criteria in the final rule accordingly.

D. Disinfectant Residual in the Distribution System

EPA proposed to require all systems using surface water (both filtered and unfiltered) to maintain at least a 0.2 mg/l disinfection residual in greater than or equal to 95 percent of the distribution system samples taken each month. If a system failed to comply with this requirement for any two consecutive months, it would be in violation of a treatment technique requirement. Also, unfiltered systems failing to meet this criterion would be required to filter. The purpose of this criterion was to:

- Ensure that the distribution system is properly maintained and identify and limit contamination from outside the distribution system when it might occur;
- Limit growth of heterotrophic bacteria and *Legionella* within the distribution system; and
- Provide a quantitative limit which, if exceeded, would trigger remedial action.

EPA proposed a minimum disinfectant residual of 0.2 mg/l because it believed that maintenance of such levels are generally feasible for most well-operated systems. However, public comments indicate that, for many systems which are well-operated (as evidenced by low levels of HPC in routine monitoring), it is not feasible to maintain the proposed minimum disinfectant residual without significantly changing existing disinfection practice (e.g., increasing existing chlorine dosages or switching to chloramine disinfection for the distribution system).

Based on these comments and additional information about current disinfection practice, EPA has revised the proposal. The final rule requires "detectable" residuals in lieu of residuals of at least 0.2 mg/l. In addition, sites that do not have "detectable" residuals, but have HPC measurements of 500/ml or less, are considered equivalent to sites with "detectable" residuals for purposes of determining compliance. Thus, under the final rule, a system may measure for either disinfectant residual or HPC at any sampling location. EPA solicited comments on these options in the May 6, 1988, notice of availability (53 FR 16352), and most commenters responding to this issue supported these alternatives.

EPA believes the absence of a disinfectant residual, rather than the presence of a disinfectant residual below some specific level, is a more accurate indicator of potential contamination at a site. The absence of a residual at a site within the distribution system indicates that the disinfectant level has been reduced, possibly as a result of localized contamination from outside the distribution system (e.g., via cross-connections or back siphonage) or from organic or inorganic materials within the distribution system (such materials, especially in the absence of a residual, may be of concern because they can serve as nutrients that enhance microbial growth). However, EPA recognizes that the absence of a disinfectant residual at a distribution system site does not necessarily indicate microbiological contamination; such contaminants simply may not be present, even in the absence of a disinfectant residual. In other words, if microbial populations are low, the lack of a disinfectant residual is not a concern. Therefore, in the final rule, sites with HPC populations of 500/ml or less are considered equivalent to sites with detectable disinfectant residuals for purposes of determining compliance. EPA believes the 500/ml HPC limit is generally feasible for most well-operated systems with well-maintained distribution systems and that water below this limit is unlikely to be subject to localized contamination or significant microbial growth.

In addition to the changes described above, EPA has added several other provisions to the final rule. Some commenters thought the proposed requirement was inappropriate for systems which introduce both undisinfected ground water and disinfected surface water into the same distribution system because dilution by the ground water (which is presumably clean and thus need not be disinfected) might lower the residual concentration below 0.2 mg/l. In this case, they argued, the requirement was both inappropriate and very difficult to meet. Therefore, for systems which have both ground and surface waters entering the distribution system, the State may allow monitoring for disinfectant residuals at points other than the sampling locations for total coliforms if such points are more representative of the treated (disinfected) surface water within the distribution system.

For systems which cannot maintain a disinfectant residual in the distribution system, if the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite conditions (i.e., if analysis cannot begin within 8 hours on samples maintained at temperatures below 4° C, with the maximum elapsed time between collection and analysis under 30 hours; APHA, 1985), and adequate disinfection is provided by that system, this disinfection requirement does apply. The State's judgment might be based upon knowledge of the public water system's distribution system, maintenance of a cross-connection control program, source water quality, and/or past coliform monitoring results.

EPA added this provision for systems which cannot monitor for HPC for the following reasons:

- The option of measuring HPC usually is not available to small systems because they generally do not have in-house laboratory capability to perform the analysis themselves and it is generally not feasible to take samples and send them to a private laboratory within the specified time limit, under the prescribed conditions.
- The integrity of the distribution system is much easier to assess in a small system than in larger systems. Also, the residence time in the distribution system of a small system is expected to be much lower than in larger systems, thereby minimizing the time for bacterial populations to grow in the water.

Under the proposed rule, a system would be required to filter if it failed to

meet the criteria for maintaining a disinfectant residual in the distribution system. Commenters objected to this criterion as a condition for avoiding filtration because the failure to meet this criterion might be caused by contamination entering the piping network within the distribution system rather than by source water contamination and failure to provide filtration. EPA has modified the proposed rule to address this concern. Under the final rule, systems are only required to filter if the failure to meet the disinfection requirements for the distribution system is caused by a deficiency in treatment of the source water. However, any failure to meet the disinfection requirements for the distribution system, regardless of cause, is still considered a violation of a treatment technique requirement.

EPA believes that the revised criteria fulfill the same objectives of the proposed criteria, but are more sensitive to site-specific considerations. Compared to the proposed rule, the requirements in the final rule allow systems to use less disinfectant in the distribution system, thus minimizing adverse effects from disinfectants and disinfection by-products. In addition, total costs will be lower because fewer systems will need to institute major changes in current treatment to meet the requirements of the final rule.

E. Watershed Control and On-Site Inspection Requirements

Under the proposed rule, to avoid filtration, systems would be required to maintain a watershed control program which minimized the potential for contamination by *Giardia lamblia* cysts and viruses in the source water that was satisfactory to the State. To avoid filtration, systems also were required to have an on-site sanitary survey performed each year that indicated to the State's satisfaction that the disinfection treatment process and watershed control program were adequately designed and maintained.

Some commenters thought that these requirements should be more detailed so as to be more easily enforceable. EPA agrees. Thus the final rule includes additional criteria which were taken from EPA's October 8, 1987 draft Guidance Manual ("draft Guidance Manual"), as suggested by public commenters. EPA believes that these revisions to the proposal make the criteria more objective and therefore more enforceable.

EPA has also changed the term "sanitary survey" to "on-site inspection" in the final rule. Under the existing National Primary Drinking Water Regulations, i.e., 40 CFR 141.2(f), a sanitary survey is defined as "an onsite review of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of such sources, facilities, equipment, operation and maintenance for producing and distributing safe drinking water." EPA believes that, for the purpose of avoiding filtration, it is not necessary for systems to address concerns which relate to the distribution system; it is sufficient that they consider criteria which relate to the effectiveness of the watershed control program and reliability of the disinfection treatment processes. Accordingly, the term "on-site inspection" in the final rule refers to the evaluation of the watershed control program and disinfection treatment process.

Although this rule only requires an on-site inspection rather than a sanitary survey to avoid filtration, EPA believes that all public water systems, including the systems covered by today's rule, should periodically undergo the more comprehensive sanitary survey, as defined in § 141.2(f), to ensure regular evaluations of the distribution system as well as watershed and treatment characteristics. Many States already have programs in place for conducting sanitary surveys, but at less frequent intervals than are required for on-site inspections in this rule. Under the total coliform rule, published elsewhere in today's **Federal Register,** EPA is requiring small systems, i.e., those collecting fewer than five total coliform samples/month, to have periodic sanitary surveys. Therefore, for unfiltered small systems, during the years when the sanitary survey is conducted, the sanitary survey will fulfill both the sanitary survey requirement of the coliform rule and the on-site inspection requirement of this rule. In the final Guidance Manual, EPA will provide guidelines for conducting both on-site inspections and sanitary surveys.

In an effort to streamline the regulatory implementation process for all the new NPDWRs promulgated under the SDWA amendments, EPA is developing guidelines for States to use in making comprehensive vulnerability assessments of all public water supplies. The purpose of such an assessment would be to evaluate the vulnerability of a system for all potential contamination (i.e., microbiological, inorganic, and organic contamination in the source water, contamination within the treatment train itself because of chemical addition, and contamination within the distribution system) and to obtain information for determining the most efficient strategy for bringing the system into compliance with all pertinent drinking water regulations. The on-site inspections required under this rule for unfiltered supplies would constitute one aspect of the comprehensive vulnerability assessment.

F. Design and Operating Requirements

Under the proposed rule, all systems would have been required to meet design and operating requirements specified by the State. Failure to meet any such requirement would be considered a violation of a treatment technique or monitoring requirement. Under § 141.32, all treatment technique and monitoring violations require public notification.

Most commenters thought it was unnecessary to classify design operating requirements as Federal treatment technique requirements since States already have such requirements (in fact, most States have permit systems in place), and if the system does not meet the State-specified design and operating requirements, the system is not allowed to operate. Many people commenting on this issue thought that EPA should allow States broad discretion to determine when public notification would be appropriate if a system failed to meet design and operating criteria imposed by the State. As an example, one commenter pointed out that, under the proposal, if a State required a public water system to monitor and meet turbidity performance criteria at each individual filter (rather than requiring that the system only monitor the combined effluent of all filtered water), and one filter of many within the system failed to meet the criteria, or the turbidity monitoring equipment for one filter failed, this would be a violation. The commenter argued that it would not be appropriate to require public notification in such situations.

EPA agrees with commenters that there are likely to be many design and operating criteria specified by the State which, if not met, would not warrant public notification. Therefore, EPA has deleted from the final rule the requirement that systems comply with design and operating conditions specified by the State. However, EPA has retained the proposed revision to Part 142 requiring States to specify enforceable design and operating criteria on a Statewide or system-by-system basis. Thus, while failure to comply with State-specified design and operating criteria does not constitute a treatment technique violation, and

public notification is not required, such a failure is a violation of State law.

G. CT Values

EPA received extensive public comments regarding the basis for the proposed CT values, the method of their calculation, and whether they should be included in the rules or just published as guidance. Major issues that were raised and how they have been addressed in the final rule are discussed in this section.

1. Unfiltered Systems

(a) *Calculation of CT values.* Under the proposal, a system would be required to calculate CT, where "T" is disinfectant contact time, the time in minutes it takes the water to move between the point of disinfectant application and a point before or at the first customer during peak hourly flow, and "C" is the residual disinfectant concentration in mg/l before or at the first customer but at or after the point contact time is measured. Many commenters thought this method of calculation was overly conservative because (a) significantly greater disinfectant residuals might be present at previous points in the treatment train, (b) most customers will receive water that has a much greater disinfectant contact time than does water at or prior to the first customer, and (c) applying criteria in the draft Guidance Manual, which states that contact time should be determined based on the time it takes water with 10 percent of the tracer concentration to appear at the sampling site, will result in much shorter contact times than under less conservative guidelines (e.g., contact time defined as the time it takes 50 percent of the tracer concentration to appear at the sampling site), and that such criteria are unnecessarily stringent.

In the May 6, 1988, notice of availability, EPA solicited comments on a different methodology to determine CT values for systems using ozone. All the commenters who addressed this issue supported the adoption of this provision in the final rule. In addition, many commenters suggested applying this provision to all disinfectants. EPA agrees that this methodology, which allows systems to determine incremental contributions to the total percent inactivation based on a series of CT measurements prior to the first customer, results in a more accurate representation of actual disinfection conditions, especially in systems having source waters with a high oxidant demand, and those systems using ozone (because it dissipates very rapidly). Accordingly, EPA has adopted this methodology for all disinfectants in the final rule.

Thus, the revised methodology for calculating CT in the final rule is as follows: Systems may measure "C" at different points along the treatment train and use this value, with the corresponding "T", to calculate the total percent inactivation. In determining the total percent inactivation, the system may calculate the CT at each point where "C" was measured and compare this with the $CT_{99.9}$ value (the CT value necessary to achieve 99.9 percent inactivation) in the rule for specified conditions (pH, temperature, and residual disinfectant concentration). Each calculated CT value (CTcalc) must be divided by the appropriate $CT_{99.9}$ value found in Tables 1.1–3.1 in the rule to determine the inactivation ratio. If the sum of the inactivation ratios, or

$$\sum \frac{CTcalc}{CT_{99.9}}$$

at each point prior to the first customer where CT was calculated is equal to or greater than 1.0, i.e., there was a total of at least 99.9 percent inactivation of *Giardia lamblia*, the system is in compliance with the performance requirement.

EPA expects the final Guidance Manual to retain the recommendation that systems determine contact time based on the time it takes water with 10 percent of the tracer concentration (T_{10}) to appear at the sampling site at peak hourly flow. This approach is supported by EPA's Science Advisory Board (1988). EPA does not believe that using a T_{50} value, which was recommended by many commenters, rather than a T_{10} value, would provide an adequate margin of safety since only 50 percent of the water, rather than 90 percent, would receive the contact time necessary to achieve the percent inactivation the CT value represents.

(b) *CT values for chlorine.* The CT values in the proposed rule were based on animal infectivity data (Hibler et al., 1987b) and application of a regression model to these data (Clark et al., 1987; Regli, 1987). To provide a margin of safety, the CT values to achieve 99.9 percent inactivation in the proposed rule were set equal to the CT values needed to achieve 99.99 percent inactivation under experimental conditions.

Many commenters recommended that EPA consider data obtained from disinfection studies using *in vitro* excystation of *Giardia lamblia* (specifically, data developed by Jarroll et al. (1981)) to develop the CT values in the final rule. Commenters indicated that CT values based on the Jarroll et al. data would be significantly lower than those in the proposed rule.

The CT values in the final rule are based on a statistical analysis (Clark et al., 1988), which considered both animal infectivity studies (Hibler et al., 1987b) and excystation studies (Jarroll et al., 1981; Rice et al., 1982; Rubin, 1988c). A multiplicative model (the one previously developed for the animal infectivity data alone, which formed the basis for CT values in the proposed rule, Clark et al., 1987) was selected to best represent the chemical reactions during the inactivation process. This model was applied to each of the data sets described above, and in various combinations (Clark et al., 1988). The animal infectivity data (Hibler et al., 1987b) were included in each of the combinations studied. The animal infectivity data were considered essential for inclusion in all the combined data sets because, unlike the other data sets, these data represented inactivation levels greater than 99.9 percent. Because of limitations with the excystation methodology, only data on conditions necessary for achieving less than 99.9 percent inactivation were available from these studies. Data at these lower inactivation levels were included in the analysis since the CT values in the rule may be used for calculating partial inactivation levels (i.e., less than 99.9 percent) which, in total, are considered in determining whether the overall minimum level of inactivation of 99.9 percent is met.

Statistical analysis indicated that combining the Hibler et al. (1987b) and Jarroll et al. (1981) data (and excluding the Rice et al. (1982) and Rubin et al. (1988c) data formed the best fit model for predicting CT values for different levels of inactivation. As a conservative regulatory strategy, Clark et al. (1988) recommended that CT values for different levels of inactivation be determined by applying first order kinetics to the 99 percent upper confidence interval of the $CT_{99.99}$ values predicted by the model. For CT values above 5 °C, where data were limited, the authors recommended that for every increase of 10 °C, the CT value be lowered by one half. This concept, which was applied for determining the CT values in the proposed rule, is also supported by Hoff (1986).

Accordingly, the best fit model (based on the Hibler et al. (1987b) and Jarroll et al. (1981) data) was applied, using the above two concepts, to determine the $CT_{99.9}$ values in the final rule. The $CT_{99.9}$ values in the final rule are between zero

and 10 percent lower than what was proposed.

(c) *CT values for ozone.* The CT values for ozone in the proposed rule were based on disinfection studies using *in vitro* excystation of *Giardia lamblia* (Wickramanayake *et al.*, 1985). CT_{99} values at 5 °C and pH 7 for ozone ranged from 0.46 to 0.64. No data on CT values were available for other pHs at 5 °C. Therefore, to obtain these data, the highest CT_{99} value, 0.64, was extrapolated using first order kinetics and multiplied by a safety factor of 3 to obtain the other $CT_{99.9}$ values in the proposed rule, as follows:

$CT_{99.9}=0.64\times3\times3/2=2.9$

CT values at temperatures above 5 °C were estimated using the same multiplier assumed for free chlorine, as discussed above. CT values at 1 °C or lower, for which no data were available, were estimated by multiplying the $CT_{99.9}$ value at 5 °C by 1.5.

A much larger safety factor was applied to the CT values for ozone than was used to determine the proposed CT values for chlorine because:

- Fewer data were available for ozone than for chlorine.
- The data available for ozone, because of the limitations of the excystation procedure, only reflect up to or slightly more than 99 percent inactivation, while the data for chlorine was based on animal infectivity studies indicating inactivation at 99.99 percent (Hibler et al., 1987b; Clark et al., 1988). Thus, extrapolation of data to determine CT values for 99.9 percent inactivation using ozone involved greater uncertainty than the determination of CT values for 99.9 percent inactivation using chlorine.
- The determination of CT at the water treatment plant also involves greater uncertainty for ozone than for chlorine because contact time and residual concentration cannot be monitored as precisely for ozone.
- EPA believed that the proposed CT values, even with a large safety factor, would be practical to achieve.

EPA applied a safety factor of two instead of three to the laboratory data to obtain the CT values in the final rule, i.e., the CT values for ozone in the final rule are two-thirds of those in the proposed rule, because:

- The laboratory data which formed the basis for the CT values used the Iodometric method for measuring ozone. The Iodometric method measures total oxidants present, not just ozone alone (e.g., this method measures ozonation by-products such as hydrogen peroxide, which is a much weaker disinfectant than ozone). The final rule requires systems to measure ozone using the Indigo method; this method measures ozone but not other oxidants. At the time of these experiments, the Iodometric method was the only prescribed method for measuring ozone in Standard Methods (16th edition, 1985). In the forthcoming 17th edition of Standard Methods, however, the Indigo method, rather than the Iodometric method, will be the recommended method for measuring ozone. Since the original CT values were based on a "C" which may have included the measurement of other oxidants in addition to ozone, the CT values from these experiments are conservative, i.e., they are probably somewhat higher than if ozone had been measured using the Indigo method.
- According to public comments received and further analysis by the Agency, the proposed CT values for ozone in the proposed rule could only be achieved at very high costs.

Depending upon source water characteristics, EPA believes that it will be feasible for many systems to use ozone to meet the revised CT values, and that these values provide an adequate margin of safety.

(d) *CT values for chlorine dioxide.* The CT values for chlorine dioxide in the proposed rule were based on disinfection studies using *in vitro* excystation of *Giardia muris* cysts (Leahy, 1985). CT_{99} values at 5 °C and pH 7 ranged from 7 to 18. The highest CT_{99} value, 18, was used as the basis for extrapolation, using the same principles as discussed for ozone, to obtain the $CT_{99.9}$ values in the proposed rule.

Limited data (i.e., at 25 °C only) indicate that chlorine dioxide is more effective for inactivating *Giardia muris* cysts at pH 9 than at pH 7 (Leahy, 1985). Because the data are limited, however, EPA proposed the same CT values for all other pHs.

Since the proposal, more data on the conditions necessary for achieving 99 percent inactivation of *Giardia muris* cysts, using *in vitro* excystation, has become available at 1 °C, 5 °C, and 15 °C (Rubin, 1988b). These new data, plus the data used to develop the CT values in the proposal, were used to develop the CT values in the final rule. The average CT_{99} value at each temperature (27.9 at 1 °C, 11.8 at 5 °C, 8.5 at 15 °C, and 4.7 at 25 °C) was extrapolated using first order kinetics and multiplied by a safety factor of 1.5 to obtain the $CT_{99.9}$ values. Thus $CT_{99.9}$ at 1 °C $=27.9\times1.5\times1.5=63$. Because of the limited data available at different pHs, the same CT values are specified for all pHs. Although most of the CT_{99} data were determined at pH 7, it is known that chlorine dioxide is more effective at pH 9. Thus, the CT values in the rule are more conservative for higher pHs than for lower pHs.

The CT values for chlorine dioxide in the final rule are about one-third less than those in the proposed rule. EPA believes the revised CT values in the rule provide an adequate margin of safety because of the additional data that was used, and because *Giardia muris* cysts, rather than *Giardia lamblia* cysts (which is the organism of concern in public water systems), were used in the laboratory experiments. Since *Giardia muris* appears to be more resistant than *Giardia lamblia* to chlorine (Leahy et al., 1987) and ozone (Wickramanayake et al., 1985), it is reasonable to assume it is more resistant to chlorine dioxide as well.

(e) *CT values for chloramines*—(1) *Inactivation of Giardia cysts.* The CT values for chloramines, based on disinfection studies using preformed chloramines and *in vitro* excystation of *Giardia muris* cysts (Rubin, 1988a; Regli, 1987), are the same in the proposed and final rules. No safety factor was applied to the laboratory data on which the CT values were based since EPA believes that chloramination, conducted in the field, is more effective than using preformed chloramines.

In the draft Guidance Manual, EPA stated that animal infectivity studies could be used to determine the CT values necessary to achieve 99.9 percent inactivation of *Giardia* cysts. EPA believes that other methodologies also may be appropriate. Therefore, in the final Guidance Manual, EPA will recommend that States also allow systems to use the methodology based on *in vitro* excystation discussed by Hoff et al., 1985, and more specifically, to determine CT values for achieving greater than or equal to 99.9 percent inactivation of *Giardia* cysts using chloramines. In addition, EPA will recommend in the final Guidance Manual that *Giardia muris* cysts be used as a model for *Giardia lamblia* cysts when conducting excystation studies because, as noted earlier, disinfection studies using excystation to measure viability indicate that *Giardia muris* cysts are more resistant to inactivation than *Giardia lamblia* cysts and thus provide a conservative estimate of disinfection effectiveness (Hoff, 1985); also, *Giardia muris* cysts are apparently not pathogenic to humans, and are thus safer to work with.

(2) *Inactivation of viruses.* Under the proposed rule, if a system used chlorine, ozone, or chlorine dioxide and achieved 99.9 percent inactivation of *Giardia* cysts (i.e., they achieved the CT values

in the rule), it was assumed that it would also achieve greater than 99.99 percent inactivation of viruses. However, the proposal explained that if a system used chloramines and was able to achieve the CT values for 99.9 percent inactivation of *Giardia* cysts, it could not be assumed that 99.99 percent or greater inactivation of viruses was also achieved.

No minimum CT values for achieving 99.99 percent inactivation of viruses were included in the proposed rule. Instead, under the proposal, systems using chloramines for primary disinfection would be required to conduct on-site challenge studies to demonstrate that they achieved at least 99.99 percent inactivation of viruses.

Since the proposal, new data have become available which indicate that Hepatitis A virus is more sensitive than *Giardia* cysts to inactivation by preformed chloramines (Sobsey, 1988). Thus, the CT values required to achieve 99.99 percent inactivation of Hepatitis A with preformed chloramines are lower than those needed to achieve 99.9 percent inactivation of *Giardia* cysts. These data contrast with other data which indicate that rotavirus is more resistant than *Giardia* cysts to preformed chloramines (Hoff, 1986). However, rotavirus is very sensitive to inactivation by free chlorine, much more so than Hepatitis A (Hoff, 1986; Sobsey, 1988). If chlorine is applied prior to ammonia, the short-term presence of free chlorine would be expected to provide at least 99.99 percent inactivation of rotavirus prior to the addition of ammonia and subsequent formation of chloramines. Thus, EPA believes it is appropriate to use the Hepatitis A data, in lieu of the rotavirus data, as a surrogate for determining minimum CT values for inactivation of viruses by chloramines, provided that chlorine is added to the water prior to the addition of ammonia.

Thus, under the final rule, a system which achieves a 99.9 percent or greater inactivation of *Giardia* cysts with chloramines is considered to be achieving at least 99.99 percent inactivation of viruses, provided that chlorine is added to the water prior to the addition of ammonia. If ammonia is added first, the CT values in the rule for achieving 99.9 percent inactivation of *Giardia* cysts cannot be considered adequate for achieving 99.99 percent inactivation of viruses. Thus, under the final rule, like the proposal, such systems must demonstrate, based on on-site challenge studies, that the system is achieving at least a 99.99 percent inactivation of viruses. Guidance for conducting such studies will be provided in the final Guidance Manual.

The proposed rule included a provision that excluded systems with no sources of human viruses within the watershed from the 99.99 percent virus inactivation requirement. This provision was based on the fact that there were no data available to indicate that viruses excreted by animals are pathogenic to humans. However, one commenter cited a study by Markwell and Shortridge (1981) indicating that a cycle of waterborne transmission and maintenance of influenza virus may exist within duck communities in southern China, and that it is conceivable that virus transmission could occur in this manner to other susceptible animals, including humans. Based on the results of this study, the exclusion in the proposal has been removed. Thus, the final rule requires that all systems, even if there is no human activity within the watershed, achieve the minimum inactivation requirements for viruses.

(f) *Alternative means for demonstrating adequate disinfection.* In the May 6, 1988, notice of availability, EPA explained why CT values were included in the proposed rule for unfiltered supplies but not for filtered supplies (52 FR 16357). EPA solicited comments on whether this rationale was reasonable. Specifically, EPA asked whether CT values for unfiltered systems should be placed in guidance rather than in the rule.

Most commenters thought that all CT values should be placed in guidance rather than in the rule to more easily allow for changes in CT values based upon new data, and to allow States flexibility in their application.

EPA has retained the CT values for unfiltered systems in the final rule because (a) the inclusion of CT values for unfiltered systems makes the rule "self-implementing" and directly enforceable, i.e., a system that does not meet the CT values must install filtration, regardless of whether the State has determined whether filtration is required for a given system (see the section entitled "Compliance," below); (b) in general, unfiltered supplies are at much greater risk to waterborne disease than are filtered supplies (from 1971 through 1985, reported waterborne disease outbreaks and illnesses were 8 and 15 times higher, respectively, in unfiltered supplies with disinfection than in filtered supplies with disinfection), so it is important to have self-implementing, directly enforceable requirements in the rule for such systems; (c) without CT values in the rule for unfiltered supplies, there would be no self-implementing, directly enforceable provision to ensure an adequate level of disinfection is provided (in contrast, filtered systems have self-implementing, directly enforceable turbidity performance criteria that indicate, at least in part, the efficiency of *Giardia* cyst and virus removal); and (d) for free chlorine, which is by far the most widely used disinfectant, especially for unfiltered supplies, EPA does not believe new data will soon become available to provide a basis for concluding that lower CT values that will achieve the required levels of *Giardia* cyst and virus inactivation.

However, EPA agrees with commenters that the CT values for chlorine dioxide, ozone, and chloramines in the final rule are based on limited data compared to the more extensive data that provide the basis for the chlorine CT values and that, for these disinfectants, new data are more likely to become available in the near future that may support different CT values or other means for determining what percent inactivation of *Giardia* cysts and viruses a disinfectant achieves. For example, pilot plant studies may show that the disinfection efficiency of ozone, because of its rapid rate of dissipation, may be better characterized by operational parameters other than CT. Also, a combination of ozone with ultraviolet light may be shown to be more effective than ozone alone in achieving the required inactivation efficiencies. As another example, for chloramines, use of on-site formation rather than preformed chloramines may prove to be significantly more efficient than the laboratory conditions in place during the studies that are the basis for the CT values in this rule, in which case, lower CT values may be appropriate (Hoff, 1986).

Recognizing that research in this field is ongoing, EPA has included a provision in the final rule which allows an unfiltered system using a disinfectant other than chlorine (i.e., chloramines, ozone, or chlorine dioxide) to demonstrate, by whatever means allowed by the State, that it is consistently meeting the 99.9 and 99.99 percent removal and/or inactivation requirements on a daily basis, instead of meeting the CT values in the rule. This method need not include use of CT values. For example, the efficiency of ozonation, under which disinfection occurs very rapidly, may best be indicated by different operational conditions (e.g., applied dosage and

energy mixing efficiencies) in place of, or in addition to, CT values. This provision is not provided for systems using only chlorine because: (1) A large data base was used for deriving the CT values in the rule and EPA believes that new data are unlikely to become available soon to support the basis for other CT values; and (2) the laboratory experiments on which the CT values are based more closely simulate field conditions for chlorine than they do for chloramines, ozone, or chlorine dioxide.

2. Filtered Systems

EPA proposed that filtered systems disinfect their water, and that the overall treatment (i.e., filtration and disinfection) achieve at least 99.9 percent removal and/or inactivation and 99.99 percent removal and/or inactivation of *Giardia lamblia* cysts and viruses, respectively. The State would determine whether the system complied with this treatment performance requirement. In the draft Guidance Manual, EPA recommended that, in general, filtration (with any pretreatment appropriate for the specific technology used) should be assumed to achieve 99 percent (2-log) to 99.9 (3-log) removal of *Giardia lamblia* cysts and 90 percent (1-log) to 99.9 percent (3-log) removal of viruses. Using this assumption, EPA recommended that, to achieve at least 99.9 percent and 99.99 percent removal and/or inactivation of *Giardia lamblia* cysts and viruses, respectively, with considerable margin of safety, a system that filters should provide disinfection which achieves at least a 90 percent (1-log) inactivation of *Giardia lamblia* cysts and a 99.9 percent (3-log) inactivation of viruses (higher levels of inactivation were recommended for systems with source waters having significant fecal contamination). For most systems, i.e., those which use chlorine, CT values which achieve greater than a 90 percent inactivation of *Giardia lamblia* cysts can be expected to achieve greater than a 99.99 percent inactivation of viruses. Thus, a system which uses chlorine and achieves greater than 90 percent inactivation of *Giardia lamblia* cysts would be assumed to satisfy the overall minimum performance requirement for viruses.

Most of the comments on CT values and the method of their calculation pertaining to unfiltered supplies also pertain to filtered supplies. Thus, most commenters thought that EPA's recommended procedures for calculating CT and the actual CT values in the draft Guidance Manual were overly conservative. According to a survey conducted by the American Water Works Association (AWWA, 1987), only 18 percent of the filtered systems participating in the survey would be able to comply year-round with the CT values recommended in the draft Guidance Manual, when calculated as recommended. Many commenters thought that systems should get credit for inactivation of *Giardia* and viruses with disinfection prior to filtration, regardless of the level of turbidity (rather than limiting such credit to systems with low turbidity), because these organisms are contained within particulate matter, and therefore are subsequently removed by either sedimentation or filtration. Some commenters thought that States should have broad discretion in how they apply the CT values in the Guidance Manual for evaluating percent inactivations for filtered supplies until the numbers are field tested and evaluated on the basis of actual experience. In contrast, however, other commenters stated that, for filtered systems, EPA should establish minimum disinfection performance standards, in the form of minimum CT values, in the rule (rather than simply making recommendations in the Guidance Manual) in order to assure uniform nationwide standards.

From 1971 through 1985, there were three reported waterborne disease outbreaks in filtered systems attributed to inadequate or interrupted disinfection versus 10 outbreaks due to inadequte filtration or pretreatment (in contrast to unfiltered supplies where there were 42 reported outbreaks due to inadequate or interrupted disinfection) (Craun, 1988). Although EPA strongly believes these statistics reflect only a small proportion of the disease outbreaks and illnesses actually occurring, EPA also believes that these data indicate, in general, that most filtered systems, when well-operated, are providing adequate levels of disinfection to protect from waterborne disease. Based on a review of these data and public comments, EPA has concluded that the many safety factors that it recommended in the draft Guidance Manual for estimating the total removal and/or inactivation of *Giardia* cysts and viruses in filtered systems, like the safety factors built into the requirements for unfiltered systems were, in total, overly conservative.

In response, the following changes will be made in the final Guidance Manual to address these concerns:

- In the draft Guidance Manual, EPA had recommended that credit toward *Giardia* and virus inactivation in the water prior to filtration be allowed only if the turbidity of that water is less than 5 and 1 NTU, respectively. The final Guidance Manual will recommend that credit be given for disinfection of *Giardia* cysts and viruses prior to filtration regardless of the turbidity level. This recommendation is based on the assumption that any pathogens present in the source water will be either removed by filtration or directly exposed to disinfection.
- The final Guidance Manual will recommend that, in general, systems using conventional treatment which are able to achieve turbidity levels of less than 0.5 NTU in the filtered water in 95 percent of the samples be assumed to achieve 2.5-log removal of *Giardia* cysts and 2-log inactivation of viruses, provided that coagulation and flocculation conditions are optimized for turbidity removal by filtration. These systems would thus only need to achieve a 0.5-log inactivation of *Giardia lamblia* cysts and a 2-log inactivation of viruses with disinfection to satisfy the overall 3-log and 4-log minimum performance requirements. EPA believes that these revisions are appropriate since sedimentation and filtration (preceded by coagulation) provide more removal of *Giardia* cysts and viruses than does filtration (preceded by coagulation) alone. This conclusion is based on two recent studies. In pilot plant studies using Ohio River water, Logsdon (1985) has shown that sedimentation achieves 0.5- to 1-log removal of *Giardia* cysts. Since filtration provides 2-log removal, it is appropriate to assume that sedimentation and filtration together provide at least 2.5-log removal. In addition, in pilot plant studies using Lake Houston water, Rao et al. (1988) have shown that sedimentation (preceded by coagulation) achieves generally greater than 90 percent removal of viruses and that sedimentation and filtration together generally achieve greater than 99 percent removal of viruses.
- The CT values for free chlorine have been lowered up to 10 percent, for the same reasons discussed above for unfiltered supplies.
- The CT values for ozone and chlorine dioxide have been lowered by about one-third, for the same reasons discussed above for unfiltered supplies.
- Regarding the use of chloramines, the final Guidance Manual will recommend that, in general, for the reasons discussed above for unfiltered systems, filtered systems which add chlorine to the water prior to ammonia addition be assumed to be achieving 99.99 percent removal and/or inactivation of viruses if they are achieving 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts.

This is a change from the draft Guidance Manual which recommended that all systems using chloramines for primary disinfection demonstrate the adequacy of virus inactivation based on on-site challenge studies. For systems which add ammonia to the water prior to chlorine, the final Guidance Manual will continue to recommend on-site challenge studies to determine the adequacy of disinfection for virus inactivation.

Figures III.1 and III.2 indicate the levels of *Giardia lamblia* cyst inactivation that filtered systems in the U.S. are currently achieving from disinfection alone, assuming the criteria in the final rule and final Guidance Manual for calculating percent inactivation were implemented. EPA estimates that 10 to 20 percent of filtered systems will need to augment existing disinfection in order to comply with this final rule and to meet the criteria recommended in the final Guidance Manual. This is a large reduction from AWWA's estimates that 82 percent of filtered systems would need to enhance their current disinfection practice to meet the criteria in the proposed rule and the draft Guidance Manual (AWWA, 1987).

H. Potential Conflict Between Today's Rule and Future Rules for Disinfectants and Disinfection By-Products

EPA intends to promulgate national primary drinking water regulations to regulate levels of disinfectants and disinfectant by-products for all systems when it promulgates disinfection requirements for groundwater systems. Many commenters expressed concern that changes that systems might need to make in their disinfection practice in order to comply with today's final rule might be inconsistent with the treatment changes necessary to comply with these forthcoming regulations for disinfectants and disinfection by-products.

EPA believes that many of the specific concerns expressed by commenters have been substantially mitigated by the changes in the final rule and planned changes in the final Guidance Manual discussed previously. As a result of these changes, EPA believes that many systems already are in compliance with today's rule, so changes in disinfection practice will not be necessary. In addition, under the final rule, the State has discretion to determine what disinfection conditions are needed for filtered systems to meet the 3- and 4-log removal and/or inactivation requirements for *Giardia lamblia* cysts and viruses (or any higher level of performance that might be specified by the State, depending upon source water quality conditions). In exercising this discretion, the State could take into account any potential conflict with forthcoming regulations for disinfectants and disinfection by-products. For example, if a system using conventional treatment is well-designed and is optimizing its clarification processes for turbidity removal, and is achieving very low filtered water turbidities, it may be appropriate for the State to give that system 3 logs of credit for *Giardia* cyst removal (in lieu of the generally recommended 2.5-log credit); in this way, the system can avoid substantial (if any) upgrades in disinfection practice and, in turn, potential increases in health risks from higher levels of disinfection by-products. In the final Guidance Manual, EPA expects to recommend that States give credit for 3 logs of *Giardia* cyst removal by conventional treatment only if: (a) The total treatment train achieves at least 99 percent turbidity removal, or filtered water turbidities are consistently less than 0.5 NTU, whichever results in lower levels; and (b) the level of HPC in the finished (disinfected) water entering the distribution system is consistently less than 10/ml.

In general, EPA believes that filtered systems need to achieve 0.5- to 1-log inactivation of *Giardia lamblia* cysts (depending on the type of filtration used) to achieve an overall 3-log removal and/or inactivation. However, it may be appropriate to allow more credit for filtration and thus require less disinfection, e.g., less than 0.5 logs for conventional treatment, until regulations for disinfectants and disinfection by-products are promulgated and the optimum treatment for achieving compliance with both regulations can be determined. However, EPA recommends that these lower levels of disinfection only be allowed if the source water is expected to have concentrations of less than one *Giardia* cyst/100 l. Likewise, for systems using slow sand filtration and diatomaceous earth filtration, EPA believes it would not be unreasonable for States to allow 2.5 or 3 logs of credit for *Giardia* cyst removal in lieu of the generally recommended guideline of 2 logs of credit, depending upon source water quality and concerns about disinfection by-products. Pilot plant studies have demonstrated (USEPA, 1988b) that these technologies, when well-operated, generally achieve these removals or better. Assuming these technologies achieve only a 2-log removal, as generally recommended by EPA for the purpose of determining the appropriate level of disinfection necessary for the system to meet the overall treatment performance standard, provides a very conservative margin of safety to control for microbiological concerns. However, EPA recognizes this assumption may not always be appropriate depending upon source water quality, reliability of system operation, and potential increased health risks from disinfection by-products. Thus, the final rule does not dictate how the State must calculate treatment efficiencies for filtered systems; it is left to State discretion.

In the final Guidance Manual EPA plans to recommend that States allow, for the interim (i.e., between now and the time EPA promulgates regulations for disinfectants and disinfection by-products), more credit for *Giardia* cyst removal (and, in turn, virus removal) only if it determines that a system is not currently at significant risk from microbiological concerns at the existing level of disinfection, and that a deferral is necessary for the system to upgrade its disinfection process to achieve compliance with this rule as well as the forthcoming regulations for disinfectants and disinfection by-products. Since EPA intends to regulate disinfectants and disinfection by-products by 1991 (*see* 53 FR 1899), and compliance with today's final rule for filtered systems is not required until June 1993, it is anticipated that most of such systems will have sufficient time to optimally address the requirements of both rules.

EPA does not believe that the same discretion discussed above for filtered systems is appropriate for unfiltered systems since (a) they are at much greater risk from waterborne disease than are filtered systems, (b) SDWA requires that the State determine whether filtration is required within 30 months following the promulgation of this rule, and the State cannot make the decision whether filtration is necessary without knowing what disinfection will be in place. Also, the installation of filtration by an unfiltered supply allows a system to use much lower levels of disinfection than is necessary in a system without filtration; as a result, levels of disinfectants and disinfectant by-products are lower in filtered systems, assuming the same source water quality conditions.

I. Turbidity Monitoring and Performance Criteria

1. Unfiltered Systems

EPA proposed that, to avoid filtration, a system demonstrate on an ongoing basis that the turbidity of the water prior to disinfection does not exceed 5 NTU, based on measurements at least

every four hours. Under the proposal, a system would not be required to filter if it occasionally exceeded the 5 NTU limit (although such an exceedance would be considered a violation of the treatment technique requirements which posed an acute risk to human health). Specifically, a system could exceed the 5 NTU limit no more than two periods during twelve consecutive months or five periods during 120 consecutive months, provided that (a) the system informed its customers and the State of the violation, as soon as possible but in no case later than 72 hours after the violation occurred, and customers were instructed to boil their water before consumption until it was determined that the water was safe, and (b) the State determined that the exceedance occurred because of unusual or unpredictable circumstances. A "period" would be defined as a series of consecutive days in which at least one turbidity measurement each day exceeded 5 NTU.

Some commenters were opposed to allowing any periods when turbidities exceeded 5 NTU since systems are most vulnerable to microbiological risk at such times. Others thought that the periods in which turbidity could exceed 5 NTU should be limited in duration. Some commenters stated that an absolute limit for turbidity was inappropriate since the significance of turbidity levels as an indicator of possible interference with disinfection depends on the size and chemical composition of the particulate matter present. Other commenters supported the proposed turbidity limits. Some commenters opposed the proposal to classify an exceedance of 5 NTU as an acute health risk since high turbidity does not necessarily indicate a health hazard, depending on the nature of the particulate matter present. Similarly, they objected to the proposal that systems issue a boil water notice to the public whenever the turbidity exceeded 5 NTU; many thought that such a requirement should be left to State discretion based upon an evaluation of actual health risk.

In the final rule, EPA has retained the provision that allows unfiltered systems to exceed the turbidity limit of 5 NTU a limited number of times, i.e., no more than two events during 12 consecutive months or five events during 120 consecutive months, as long as the State is informed of each exceedance and determines that it was caused by unusual or unpredictable circumstances. (In the final rule, EPA uses the term "event" rather than "period.") EPA believes that the other requirements for avoiding filtration in the rule ensure a high probability that adequate treatment is still being provided if the turbidity were to exceed 5 NTU for short periods of time. These include the requirements to (a) comply with fecal or total coliform source water quality limits; (b) maintain disinfection conditions sufficient to achieve at least 99.9 and 99.99 percent inactivation of *Giardia lamblia* cysts and viruses, respectively, as indicated by meeting the CT requirements; (c) comply with the total coliform MCL (the coliform rule, published elsewhere in today's **Federal Register**, requires unfiltered surface waters to take coliform measurements at or near the first customer on days when the turbidity exceeds 1 NTU and to include these measurements in the MCL compliance determination); and (d) maintain a watershed control program to restrict human activities. The requirement to have a watershed control program reduces the probability that human viruses will be present in large numbers, so there is less concern about turbidity interfering with disinfection of viruses. In addition, there is much less concern about turbidity interfering with inactivation of *Giardia* cysts by disinfection than viruses or bacteria since *Giardia* cysts are much larger than viruses and bacteria and are less likely to be occluded or protected by particulate matter.

The final rule does not specify a maximum duration for a turbidity event, as a condition for avoiding filtration, since other requirements (discussed above) must also be met to avoid filtration; EPA expects that, if the duration of an event is long, and the system is at risk (which will depend on the nature of the particulate matter causing the high turbidity level, and the source water quality), one of the other requirements for avoiding filtration is likely to be exceeded, thereby requiring the system to install filtration.

EPA agrees with public commenters who stated that interference with disinfection by turbidity will depend on the nature of the particulate matter that is present. However, as discussed in the proposal, EPA believes an upper limit of 5 NTU is appropriate. Increases in turbidity occurrence levels from less than 1 NTU to greater than 5–10 NTUs have been shown to correlate with decreases in disinfection effectiveness in unfiltered source waters (Le Chevalier et al., 1981). In addition, high turbidity waters may be unaesthetic in appearance and cause consumers to avoid use of the public water supply and possibly choose less safe waters.

The requirement that systems inform their customers to boil their water before consumption when source water turbidities exceed 5 NTU has been deleted from the final rule. EPA agrees with the commenters that States should determine if such an order should be issued, since certain site-specific factors might not warrant such action. Also, in the final rule, an exceedance of the turbidity limit of 5 NTU is considered a violation of a treatment technique requirement, but not, as proposed, one which poses an acute risk to human health. Therefore, violation of the 5 NTU limit does not require a system to notify the public via electronic media, posting, or hand delivery, depending on system type, within 72 hours. (Only written notice is required, as specified for Tier 1 violations. *See* the public notification regulations at 40 CFR 141.32.)

2. Filtered Systems

EPA proposed to require systems that filter to measure the turbidity level of a representative sample of filtered water every four hours when water is being delivered to the distribution system. For a system using conventional treatment or direct filtration, EPA proposed to require that the turbidity level of the system's filtered water be less than or equal to 0.5 NTU in at least 95 percent of the measurements taken each month. For a system using slow sand or diatomaceous earth filtration, EPA proposed to require that the turbidity level be less than 1 NTU in at least 95 percent of the measurements taken each month. Under the proposal, for systems using conventional treatment or direct filtration, if the State determined that on-site studies demonstrated at least 99.9 percent overall removal and/or inactivation of *Giardia* cysts, the State could specify a higher turbidity limit, up to 1 NTU in 95 percent of the samples in a month.

Many commenters, especially those representing small systems, favored retaining the current turbidity monitoring requirements in the interim regulations, i.e., one sample per day (40 CFR 141.22). Commenters claimed that monitoring of turbidity every four hours, or by continuous monitoring and recording equipment, is not feasible for small systems. In addition, many commenters objected to the 0.5 NTU limit for systems using conventional treatment or direct filtration; they favored retaining the existing standard of 1 NTU. Some commenters stated there is no evidence that the more stringent turbidity criteria EPA proposed would result in increased health protection, i.e., fewer waterborne disease outbreaks, compared to the existing turbidity MCL. Commenters

stated that many systems, especially smaller systems, would incur significant costs to make treatment changes to comply with the proposed turbidity criteria. In a survey by AWWA (1987), which sampled mostly large systems, 24 percent of the filtered systems which responded did not have filtered water with turbidity less than 0.5 NTU 95 percent of the time.

Some commenters supported the 0.5 NTU limit, claiming it would significantly improve the quality of drinking water nationwide. Other commenters supported the 0.5 NTU limit but only for large systems; they suggested EPA promulgate a separate limit of 1 NTU for small systems. Still other commenters favored the 0.5 NTU limit but thought the rule should allow the State to increase the limit if there was evidence of effective removal of *Giardia* cysts or *Giardia* cyst-sized particles at higher turbidities.

In response to these comments, EPA requested comment on alternatives to the proposed turbidity provisions in the May 6, 1988, notice of availability (53 FR 16354). Most commenters responding to this issue supported these changes. As a result, many have been included in the final rule. These changes are described below.

The final rule allows the State to reduce the monitoring frequency for turbidity to one grab sample per day for systems serving 500 or fewer people if the State finds that the historical performance and operation of the system indicates effective particulate removal under the variety of conditions expected to occur in that system. EPA believes this provision for reduced monitoring is appropriate because, for very small systems, grab sample monitoring every four hours of operation may not be feasible (i.e., it is economically infeasible to provide the degree of operator attention necessary to conduct such monitoring; likewise, it is costly to install and impractical to maintain automated turbidity monitoring equipment). At the reduced monitoring frequency, the same performance criteria would apply. Thus, for instance, if two or more of the 30 samples taken in one month exceed the turbidity limit, then less than 95 percent of the samples would meet the turbidity performance criterion, and the system would be in violation of a treatment technique requirement.

EPA believes that it is feasible for most systems using conventional treatment or direct filtration to achieve the turbidity performance criterion of 0.5 NTU (see 52 FR 42200, 42205–42206). EPA believes it is generally necessary for systems using conventional treatment or direct filtration to meet this turbidity limit to achieve at least 99.9 percent removal and/or inactivation of *Giardia* cysts with filtration and disinfection. EPA recognizes that many existing filtered systems currently may not be meeting the proposed turbidity limit; however, EPA believes that most of these systems can meet these limits with treatment modifications that involve very low costs (*see* Table VI–3).

EPA recognizes that it may be possible for some systems that currently are not meeting the turbidity performance criterion, depending upon raw water quality and other treatment characteristics, to still achieve the overall minimum (or better) removal and/or inactivation of *Giardia* cysts. Therefore, the final rule allows a system to operate at higher filtered turbidities, up to 1 NTU in at least 95 percent of the measurements, if the State determines that the system is achieving the minimum performance requirement of 99.9 percent removal and/or inactivation of *Giardia* cysts at the higher turbidity level. Unlike the proposal, the final rule does not require the system to actually demonstrate (e.g., with pilot plant study results) it is achieving the minimum performance requirements at the higher turbidity level to be allowed to operate at this level. Instead, the State's determination may be based upon an analysis of existing design and operating conditions (e.g., adequacy of treatment prior to filtration, percent turbidity removal across the entire treatment train, stringency of disinfection) and/or performance relative to certain water quality characteristics (e.g., microbiological analysis of the filtered water, particle size counts in water before and after filtration). The State may wish to consider such factors as source water quality and system size in determining the extent of analysis necessary. The final Guidance Manual will provide additional guidance to the States for determining when a higher turbidity limit might be appropriate.

For any filtration technology, EPA believes that filtered water turbidities should generally be less than 1 NTU in order to prevent interference with disinfection of viruses. Allowing an average turbidity of less than 1 NTU, as some commenters suggested, would allow systems to exceed 1 NTU a high percentage of the time, during which time there might be interference with disinfection. Therefore, EPA has set an upper limit for turbidity of 1 NTU in 95 percent of the measurements, rather than specifying an average. As in the proposal, exceptions to this limit are allowed for slow sand filtration, up to 5 NTU, but at no time exceeding 5 NTU, if the system demonstrates to the State that there is no interference with disinfection, because studies demonstrate that slow sand filters can achieve greater than 99.9 percent removal of *Giardia* cysts by filtration alone at turbidities exceeding 1 NTU (Bellamy et al., 1985a, b).

The additional flexibility in the final rule will allow States to apply engineering judgment, as appropriate, to determine what information is necessary for demonstrating adequate treatment performance. EPA anticipates that this added flexibility will reduce costs, especially for small systems, while still ensuring that adequate treatment is in place.

IV. Description of the Final Rule

EPA believes that all surface waters and ground water under the direct influence of surface water are at risk, at least to some degree, from contamination by *Giardia lamblia* and other protozoa, viruses, and pathogenic bacteria and that public water systems using such source waters should provide minimum levels of treatment to ensure protection from illness caused by these contaminants. Therefore, this rule applies to all public water systems (both community and non-community) which use a surface water source or a ground water source under the direct influence of surface water.

This rule defines "surface water" as all water open to the atmosphere and subject to surface runoff (e.g., rivers, lakes, streams, reservoirs, impoundments). This rule defines "ground water under the direct influence of surface water" as:

> any water beneath the surface of the ground with (i) significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*, or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Direct influence must be determined for each individual source in accordance with criteria established by the State. The State determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation.

The State is responsible for determining whether a system uses ground water under the direct influence of surface water and is, therefore, subject to the requirements of this rule. Determinations of whether a ground water system is under the direct influence of surface water must be made within 5 years following the

promulgation date of this rule for community water supplies and within 10 years following the promulgation date of this rule for non-community water systems. Procedures that may be used for determining whether there is direct influence by surface water will be included in the final Guidance Manual. States may choose to apply general guidelines based on source characteristics to expedite the determination for easily characterized sources, and to apply more specific criteria, including microbiological analysis, for sources more difficult to characterize. For systems which use mixed source water supplies (i.e., ground water not under the direct influence of surface water and surface water), this rule applies only to the water originating from the surface water source.

A. Operator Personnel Requirements

Under the final rule, all systems using surface water or ground water under the direct influence of surface water must be operated by personnel that meet qualifications specified by the State. As described later, States must develop operator qualifications if they do not already have them and require that systems be operated by personnel who meet these qualifications. The appropriate criteria for determining if an operator is qualified depend upon the type and size of the system. EPA encourages States which do not yet have operator license certification programs in effect to develop such programs.

B. Treatment Requirements

1. Summary

Under this rule, all community and non-community public water systems using any surface water source must treat their surface water source(s) to achieve at least 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts, and at least 99.99 percent removal and/or inactivation of viruses. A system is deemed to be in compliance with this requirement if it complies with the treatment technique requirements specified in this rule. At a minimum, the treatment required for any surface water must include disinfection.

Thus, systems with very clean and protected source waters that meet the source water quality criteria (including low total coliform or fecal coliform levels and low turbidity levels, as specified in the rule) and certain site-specific criteria (including an effective watershed control program), are required to use only disinfection to achieve 99.9 percent and 99.99 percent inactivation of *Giardia lamblia* cysts and viruses, respectively. If such systems can continually meet the applicable CT values specified in the rule (or, if a disinfectant other than chlorine is used, other criteria specified by the State), the system is considered to be in compliance with the required removal and/or inactivation requirements for *Giardia lamblia* and viruses without monitoring for these organisms. Systems which cannot meet the source water quality criteria and site-specific criteria of this rule are required to filter their water.

Systems required to filter can use a variety of treatment technologies to meet the minimum 99.9 and 99.99 percent performance levels. A system with filtration that achieves certain turbidity levels and meets specified disinfection requirements is deemed to be in compliance with these performance requirements.

For most source waters in the United States, EPA considers conventional treatment (which includes coagulation, flocculation, sedimentation, rapid granular filtration, and disinfection) to be the best technology for controlling microbiological contaminants because of the multiple barriers of protection that it provides. Conventional treatment has been demonstrated to achieve at least 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses under appropriate design and operating conditions (USEPA, 1988b); it is the benchmark against which water treatment decisions should be judged. Direct filtration (which includes coagulation), slow sand filtration, and diatomaceous earth filtration, each with disinfection, also have been demonstrated to achieve at least 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses under appropriate design and operating conditions (USEPA, 1988b).

Under the final rule, a public water system also may use a filtration technology other than the four specified above if it demonstrates to the State using pilot plant challenge studies, or other appropriate means, that the filtration technology, in combination with disinfection, achieves at least 99.9 percent and 99.99 percent removal and/or inactivation of *Giardia lamblia* cysts and viruses, respectively. In addition, the State may approve a technology demonstrated to be effective at one site for use at another site if the source water quality conditions at the two sites are similar.

In determining the appropriate technology to be used, source water quality, site-specific factors (e.g., available land, location of the treatment plant relative to the water source, waste-disposal concerns), and cost effectiveness need to be considered. In general, the level of treatment provided should be commensurate with the potential for pathogen contamination in the source water. Table IV–1 provides guidelines for selecting filtration technology(ies) to be used based on source water quality. EPA recommends conducting pilot plant studies to help determine the most appropriate filtration technology and the optimum design conditions. More detailed guidelines for determining the appropriate technology and design conditions will be included in the final Guidance Manual.

TABLE IV–1.—GENERALIZED CAPABILITY OF FILTRATION SYSTEMS TO ACCOMMODATE VARIOUS RAW WATER QUALITY CONDITIONS

Treatment technology	General constraints (i.e., indicated values occasionally could be exceeded)		
	Total coliforms (#/100 ml)	Turbidity (NTU) [1]	Color (CU) [2]
Conventional Treatment	<20,000	no restrictions.	<75
(with no predisinfection)	<5,000	no restrictions.	<75
Direct Filtration	<500	<7–14	<40

TABLE IV-1.—GENERALIZED CAPABILITY OF FILTRATION SYSTEMS TO ACCOMMODATE VARIOUS RAW WATER QUALITY CONDITIONS—Continued

Treatment technology	General constraints (i.e., indicated values occasionally could be exceeded)		
	Total coliforms (#/100 ml)	Turbidity (NTU) [1]	Color (CU) [2]
Slow Sand Filtration	<800	<10	<5
Diatomaceous Earth Filtration	<50	<5	<5

[1] Nephelometric turbidity units.
[2] Colorimetric units.

2. Criteria for Determining if Filtration Is Required

Under the final rule, a public water system using surface water must use filtration unless it meets the following criteria:

Source Water Quality Criteria
- Coliforms
- Turbidity

Site-specific Criteria
- Disinfection
- Watershed control
- On-site inspection
- Absence of waterborne disease outbreaks
- Total coliform maximum contaminant level (MCL)
- Total trihalomethanes (TTHMs) MCL

These criteria are described in detail below.

(a) *Source Water Quality Criteria*—(1) *Coliform limits.* To avoid filtration, a system must meet one of the following criteria: (1) The fecal coliform concentration in water prior to disinfection is equal to or less than 20/100 ml in at least 90 percent of the samples; or (2) the total coliform concentration in water prior to disinfection is equal to or less than 100/100 ml in at least 90 percent of the samples. If a system monitors for both parameters, it may exceed the total coliform limit, but not the fecal coliform limit, and still avoid filtration, while a system that meets the total coliform limit, but not the fecal coliform limit, must install filtration. Minimum sampling frequencies for different system sizes are as follows:

Population served	Samples/week [1]
<500	1
501 to 3,300	2
3,301 to 10,000	3
10,001 to 25,000	4
>25,000	5

[1] Must be taken on separate days.

This sampling must include one measurement on every day during which the turbidity exceeds 1 NTU (unless the State determines that the system, for logistical reasons outside the system's control, cannot have the sample analyzed within 30 hours of collection). This sample counts towards the total number that must be taken each week.

The coliform limits are an ongoing requirement; at the end of each month, the system must evaluate the data collected for the preceding six months the system served water to the public and determine if this source water quality condition is still being met. If the criterion has not been met, the system must install filtration.

(2) *Turbidity limits.* To avoid filtration, the turbidity of the water prior to disinfection cannot exceed 5 NTU, on an ongoing basis, based on grab samples collected every four hours (or more frequently) that the system is in operation. A system may substitute continuous turbidity monitoring for grab sample monitoring if it validates such measurements for accuracy with grab sample measurements on a regular basis, as specified by the State. If a public water system uses continuous monitoring, it must use turbidity values recorded every four hours (or some shorter regular time interval) to determine whether it meets the turbidity limit for raw water. A system occasionally may exceed the 5 NTU limit and still avoid filtration as long as (a) the State determines that each event occurred because of unusual or unpredictable circumstances and (b) as a result of this event, there have not been more than two such events in the past twelve months the system served water to the public or more than five such events in the past 120 months the system served water to the public. An "event" is defined as a series of consecutive days in which at least one turbidity measurement each day exceeds 5 NTU.

It is important to note that every event, i.e., exceedance of the 5 NTU limit, regardless of whether the system must filter as a consequence, constitutes a violation of a treatment technique requirement. For example, if the turbidity exceeded 5 NTU in at least one measurement each day for three consecutive days, this would constitute one event and one treatment technique violation. If this was the third event in the past 12 months the system served water to the public, or the sixth event in the past 120 months the system had served water to the public, the system also would be required to install filtration. In all cases, the system must inform the State when the turbidity exceeds 5 NTU as soon as possible, but no later than the end of the next business day.

(b) *Site-Specific Criteria*—(1) *Disinfection requirements.* To avoid filtration, this rule requires that a system practice disinfection and have either (a) redundant disinfection capability, including an auxiliary power supply with automatic start-up and alarm, to ensure that continuous disinfection is provided; or (b) automatic shut-off of delivery of water to the distribution system whenever the disinfectant residual is less than 0.2 mg/l in the water. A system that fails to meet either of these requirements must install filtration. The option of automatic shut-off is not permitted if the State determines that this action could cause an unreasonable risk to health (e.g., automatic shut-off is not appropriate if it results in negative pressures within the distribution system or inadequate water supplies for fire protection).

(i) *Maintenance of a disinfectant residual at the point of entry.* To avoid filtration, the disinfectant residual in water entering the distribution system cannot be less than 0.2 mg/l for more than four hours, with one exception noted below. Systems serving more than 3,300 persons must monitor continuously. If there is a failure in the continuous monitoring equipment, the system may substitute grab sampling every four hours for up to five working days following the failure of the equipment. Systems serving 3,300 or fewer people may monitor continuously

or take grab samples at the frequencies prescribed below:

System size by population	Samples/day [1]
<500	1
50 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

[1] Samples cannot be taken at the same time. The sampling intervals are subject to State review and approval.

If at any time the residual disinfectant concentration falls below 0.2 mg/l in a system using grab sample monitoring, the system must continue to take a grab sample every four hours until the residual disinfectant concentration is equal to or greater than 0.2 mg/l. For all systems, if the residual concentration is not restored to at least 0.2 mg/l within four hours after a value of less than 0.2 mg/l is observed, the system is in violation of a treatment technique requirement, and must install filtration. However, if the State finds that the exceedance was caused by an unusual and unpredictable circumstance, the State may choose not to require filtration. EPA expects the States to use this provision sparingly; it is intended to encompass catastrophic events, not infrequent large storm events. In addition, any time the residual concentration falls below 0.2 mg/l, the system must notify the State. Notification must occur as soon as possible, but no later than by the end of the next business day. The system also must notify the State by the end of the next business day whether or not the residual was restored within four hours.

(ii) *Minimum percent inactivation requirements.* To avoid filtration, a system must maintain disinfection operational conditions which inactivate 99.9 percent of *Giardia lamblia* cysts and 99.99 percent of viruses. To make this demonstration, the system must determine disinfectant residual(s), disinfectant contact time(s), pH, and water temperature, and use these data to calculate whether it is meeting the minimum total percent inactivation requirements in the rule. (The CT values necessary to achieve 99.9 percent inactivation of *Giardia lamblia* cysts and 99.99 percent inactivation of viruses by various disinfectants and under various conditions are specified in the rule.) A system is deemed in compliance with the inactivation requirements if the CT value(s) calculated for its disinfection conditions meet (or exceed) the relevant CT value specified in the rule. The system must make this determination each day that it is delivering water to its customers. For disinfectants other than chlorine, a system may demonstrate, through use of a State-approved protocol for on-site disinfection challenge studies or other information satisfactory to the State, that disinfection conditions other than those specified in the rule are adequate for meeting the minimum levels of inactivation.

For the purpose of calculating CT values, disinfection contact time (in minutes) is the time it takes the water, during peak hourly flow, to move between the point of disinfectant application (or the previous point of measurement) to a point before or at the point where the residual disinfectant concentration (in mg/l) is measured (which in turn must be before or at the first customer). The point of disinfectant application is defined as the point where the disinfectant is applied and water downstream of that point is not subject to recontamination by surface water runoff. Contact time in pipelines must be calculated based on "plug flow" (i.e., where all water moves homogeneously in time between two points) by dividing the internal volume of the pipeline by the peak hourly flow rate through that pipeline. Contact time within mixing basins and storage reservoirs must be determined by tracer studies or an equivalent demonstration.

Under this rule, systems with only one point of disinfectant application may measure "C" at any number of points within the treatment train, determine each corresponding "T" and thereby calculate the CTs for each sequence to determine the percent inactivation achieved. The total inactivation ratio achieved is the sum of all the fractional inactivations calculated for each point where disinfectant residual was measured. To determine the total inactivation ratio achieved using this method, the system must calculate the CT for each point where "C" was measured (CTcalc) and compare this with the $CT_{99.9}$ value (the CT value required to achieve 99.9 percent inactivation of *Giardia* cysts) given in the rule for the particular conditions (pH, temperature, and residual disinfectant concentration) at that point. Specifically, the system must divide each calculated CT value by its corresponding $CT_{99.9}$ value in the rule to determine the inactivation ratio for each point where "C" was measured. If the sum of the inactivation ratios, or

$$\sum \frac{CTcalc}{CT_{99.9}},$$

is equal to or greater than 1.0 (i.e., the sum of all the sequences for which CT was calculated before or at the first customer provides 99.9 percent or more inactivation of *Giardia lamblia* cysts), the system is meeting the disinfection performance requirement. In other words, if: $C_1T_1/CT_{99.9} + C_2T_2/CT_{99.9} + C_3T_3/C\,T_{99.9} + \ldots + C_nT_n/CT_{99.9} \geq 1.0$ (where $CT_{99.9}$ is specified in the rule for each combination of C_1, C_2, C_3, . . . C_n; temperature; and pH), the system is meeting the disinfection performance requirement.

Systems need only calculate one CT (CTcalc) each day for a point before or at the first customer. Alternatively, systems have the option of calculating multiple CTs after the point of disinfectant application but before or at the first customer to determine the inactivation ratio. If one CT is calculated (CTcalc) and this exceeds the applicable $CT_{99.9}$, the system is meeting the disinfection performance requirement; this may be all that is necessary for systems with very low oxidant demand in the water or systems where it is obvious they will achieve at least 99.9 percent inactivation.

For systems with multiple points of disinfectant application (e.g., ozone followed by chlorine, or chlorine applied at two different points in the treatment train), the inactivation ratio of each disinfectant sequence before or at the first customer must be used to determine the total inactivation ratio. The disinfectant residual of each disinfection sequence and the corresponding contact time must be determined at some point prior to the subsequent disinfection application point(s) to determine the inactivation ratio for that sequence, and whether the total inactivation ratio of 1.0 or greater is achieved. For example, if the first disinfection sequence provided an inactivation ratio of ⅔ (or 99 percent inactivation) and the second disinfection sequence provided an inactivation ratio of ⅓ (or 90 percent inactivation), the total inactivation ratio would equal 1.0 (⅔ + ⅓ = 1). The total percent inactivation could also be determined as follows:

$$\% \text{ inactivation} = 100 - \frac{100}{10^y}$$

$$\text{where } y = \sum \frac{(CTcalc)}{(CT_{99.9})} \times 3$$

If the system fails to achieve at least 99.9 percent inactivation (i.e., the

inactivation ratio is less than 1.0) any two or more days in one month, the system is in violation of a treatment technique requirement for that month. If this violation occurs during a second month in any 12 consecutive months the system serves water to the public, the system must install filtration, unless the State determines that at least one of these violations was caused by circumstances that were unusual and unpredictable. A third violation in 12 months, regardless of the cause, triggers filtration.

Guidance for determining the percent inactivation of *Giardia* cysts and viruses under different conditions will be provided in the final Guidance Manual.

(iii) *Maintenance of a disinfectant residual in the distribution system.* To avoid filtration, the disinfectant residual in the distribution system cannot be undetectable in more than five percent of the samples in a month, for any two consecutive months that the system serves water to the public. Systems may measure HPC instead of disinfectant residual. Sites with HPC concentrations of less than or equal to 500/ml are considered equivalent to sites with detectable residuals for the purpose of determining compliance. Public water systems must monitor for the presence of a disinfectant residual (or HPC levels) at the same frequency and locations as total coliform measurements taken pursuant to the total coliform regulation published elsewhere in today's **Federal Register**. However, if the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory within the requisite time and temperature conditions (Method 907, APHA, 1985), but that the system is providing adequate disinfection in the distribution system, this requirement does not apply to that system.

For systems which use both surface and ground water sources, the State may allow the system to take disinfectant residual or HPC samples at points other than the total coliform sampling locations if the State determines that such points are more representative of treated (disinfected) water quality within the distribution system.

If a system fails to maintain a detectable disinfectant residual or an HPC level of less than or equal to 500/ml in more than 5 percent of the samples during a month, for any two consecutive months the system serves water to the public, the system is in violation of a treatment technique requirement. In addition, this system must install filtration unless the State determines that the violation was not due to a deficiency in treatment of the source water (e.g., the violation was due to a deficiency in the distribution system, such as cross-connection contamination or failure in the pipeline).

(2) *Watershed control requirements.* To avoid filtration, systems must establish and maintain an effective watershed control program to minimize the potential contamination by *Giardia lamblia* cysts and viruses in the source water.

The State must determine whether the watershed control program is adequate to limit potential contamination by *Giardia lamblia* cysts and viruses. In making this determination, the State must consider the comprehensiveness of the watershed review; the effectiveness of the system's program to monitor and control activities occurring in the watershed that could have an adverse effect on water quality; and the extent to which the system has maximized land ownership and/or control of land use within the watershed. At a minimum, the watershed control program must: (1) Characterize the watershed hydrology and land ownership; (2) identify watershed characteristics and activities which may have an adverse effect on source water quality; and (3) monitor the occurrence of activities which may have an adverse effect on source water quality. The public water system must demonstrate through ownership or written agreements with landowners in the watershed, or a combination of both, that it controls all human activities which may have an adverse effect on the microbiological quality of the source water. The system must submit an annual report to the State that identifies any special concerns about the watershed and how they are being handled; describes activities in the watershed that affect water quality; and projects what adverse activities are expected to occur in the future and describes how the public water system intends to address them. For systems using a ground water source under the direct influence of surface water, an approved wellhead protection program developed under section 1428 of the Safe Drinking Water Act may be used, if the State deems it appropriate, to meet these requirements. Guidance for developing and maintaining an effective watershed control program will be included in the final Guidance Manual.

(3) *On-site inspection requirements.* To avoid filtration, a system must have an annual on-site inspection conducted by the State, or by a party approved by the State, which demonstrates that the system is maintaining an adequate watershed control program and reliable disinfection treatment. The purpose of the on-site inspection is to identify all microbiological health hazards and assess their present and future importance. The on-site inspection must include:

(a) A review of the effectiveness of the watershed control program;

(b) A review of the physical condition of the source intake and how well it is protected;

(c) A review of the system's equipment maintenance program to ensure that there is low probability for failure of the disinfection process;

(d) An inspection of the disinfection equipment for physical deterioration;

(e) A review of operating procedures;

(f) A review of data records to insure that all required tests are being conducted and results recorded, and that disinfection is effectively practiced; and

(g) Identification of any improvements which are needed in the equipment, system maintenance and operation, or data collection.

The on-site inspection must be conducted by a competent individual(s) such as a sanitary or civil engineer, sanitarian, or technician who has experience in and knowledge about the operation and maintenance of a water system, and who has a sound understanding of public health principles and waterborne diseases. A report of the on-site inspection summarizing all findings must be prepared every year. The State will review the report and determine whether the system is maintaining an adequate watershed control program and reliable disinfection treatment. EPA will include detailed suggestions for conducting an on-site inspection and interpreting the results in the final Guidance Manual.

(4) *Absence of waterborne disease outbreaks.* To avoid filtration, a system cannot have been identified as a source of waterborne disease outbreak, or if it has been so identified, the system must have been modified sufficiently to prevent another such occurrence, as determined by the State. An unfiltered system that has a waterborne disease outbreak is in violation of a treatment technique requirement which poses an acute risk to health. A "waterborne disease outbreak" is defined as a significant occurrence of acute infectious illness that the State or local health agency has determined to be epidemiologically associated with the ingestion of water from a public water system that is deficient in treatment.

(5) *Compliance with the total coliform maximum contaminant level (MCL).* To

avoid filtration, a system must comply with the MCL for total coliforms, published elsewhere in today's Federal Register, at least 11 out of the previous 12 months the system served water to the public on an ongoing basis, unless the State determines that failure to meet this requirement was not caused by a deficiency in treatment of the source water. If the State makes such a determination, the system is not required to install filtration. The total coliform rule requires systems using surface water or ground water under the influence of surface water which do not filter to collect a sample at or near the first customer each day that the turbidity level exceeds 1 NTU within 24 hours of learning of the result and to analyze the sample for the presence of total coliforms. (If the State determines that it is not possible for the system to have such a sample analyzed within 24 hours, this time limit may be extended on a case-by-case basis.) This sample may be used to fulfill the routine compliance monitoring requirements of the total coliform rule. The results of the additional sample must be included in determining whether the system is in compliance with the monthly MCL for total coliforms.

(6) *Compliance with the total trihalomethane MCL.* To avoid filtration, a system must comply with the total trihalomethane (TTHM) regulation (40 CFR 141.12 and 141.30). An unfiltered system that violates the TTHM regulation must install filtration. Currently, this requirement only applies to systems serving more than 10,000 people. When new regulations for disinfection by-products are promulgated, EPA expects they will apply to smaller systems as well as these larger systems. At that time, those smaller systems would be required to comply with these requirements to avoid filtration.

3. Criteria for Determining if Treatment is Adequate for Filtered Systems

Systems which fail to meet one or more of the above criteria for avoiding filtration must install filtration. This section describes the performance criteria for these systems which must install filtration, as well as systems that already are filtering their water

(a) *Disinfection requirements.* Under this final rule, the requirements for maintaining a disinfectant residual at the entry point to the distribution system and in the distribution system described above for unfiltered systems also apply to filtered systems. The State must determine the level of disinfection required for each system to ensure that the total treatment process (i.e., filtration and disinfection) achieves at least a 99.9 percent (3-log) and 99.99 percent (4-log) removal and/or inactivation of *Giardia lamblia* cysts and viruses, respectively. The final Guidance Manual will recommend different levels of disinfection as a function of different treatment technologies and source water qualities.

(b) *Turbidity monitoring requirements.* Under this rule, systems serving more than 500 people which use conventional treatment, direct filtration, or diatomaceous earth filtration must monitor the turbidity of representative filtered water by grab sample every four hours (or more frequently) that the system is in operation. A system may substitute continuous turbidity monitoring for grab sampling if it validates such measurements for accuracy with grab sample measurements on a regular basis, as specified by the State. If a system uses continuous monitoring, it must use the turbidity value for every four-hour interval (or some shorter regular time interval) to determine compliance with the turbidity performance criterion.

For systems using slow sand filtration or technologies other than conventional treatment, direct filtration, or diatomaceous earth filtration (such as cartridge filtration), the State may reduce the sampling frequency for turbidity to one sample per day if the State determines that less frequent monitoring is sufficient to indicate effective filtration performance.

For systems serving 500 or fewer people, the State may reduce the sampling frequency to once per day, regardless of the type of filtration treatment used, if the State determines that less frequent monitoring is sufficient to indicate effective filtration performance.

(c) *Turbidity performance criteria—*(1) *Conventional treatment or direct filtration.* For systems using conventional treatment or direct filtration, the final rule requires that the filtered water turbidity level be less than or equal to 0.5 NTU in 95 percent of the measurements taken every month, and at no time exceed 5 NTU. The system must inform the State when the turbidity exceeds 5 NTU as soon as possible, but not later than the end of the next business day.

The State may allow any system an alternate turbidity limit, up to 1 NTU in 95 percent of the meassurements, if the State determines that the system is achieving the minimum overall performance requirement of 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts at the higher turbidity level. Such a determination may be based upon an analysis of existing design and operating conditions (e.g., adequacy of treatment prior to filtration, percent turbidity removal across the entire treatment train, and level of disinfection), and/or filtration effectiveness relative to certain water quality measurements (e.g., microbiological analysis of the filtered water, particle size counting before and after the filter). Under this provision, the State may consider such factors as source water quality, extent of treatment, and system size to determine the analysis necessary to justify the higher turbidity limit. In the final Guidance Manual, EPA will provide additional information for determining when it may be appropriate to allow higher turbidity performance criteria.

All systems are expected to optimize their treatment so as to achieve the lowest turbidities feasible at all times. This will promote optimal removal of *Giardia lamblia* cysts and other pathogens, and provide optimal conditions for disinfection.

(2) *Slow sand filtration.* For systems using slow sand filtration, the final rule requires that the filtered water turbidity be 1 NTU or less in 95 percent of the measurements taken each month and at no time exceed 5 NTU. However, the State may allow a turbidity value greater than 1 NTU, but below 5 NTU, in 95 percent of the measurements if the State determines there is no significant interference with disinfection at the higher turbidity level. The system must inform the State when the turbidity exceeds 5 NTU as soon as possible, but not later than the end of the next business day.

(3) *Diatomaceous earth filtration.* For systems using diatomaceous earth filtration, the filtered water turbidity must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month. At no time may the turbidity exceed 5 NTU. The system must inform the State when the turbidity exceeds 5 NTU as soon as possible, but not later than the end of the next business day.

(4) *Other filtration technologies.* A public water system may use a filtration technology other than one described above if it demonstrates to the State, using pilot plant studies, conducted on-site or at another site with similar source conditions, that the alternative filtration technology, together with disinfection, consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses. The system must meet the same

turbidity limits prescribed for slow sand filtration.

C. Reporting Requirements

Reporting requirements for all public water systems which use a surface water source or a ground water source under the influence of surface water are specified in § 141.75 of the final rule. These reports are designed to document compliance with the treatment and monitoring requirements in §§ 141.71, 141.72, 141.73, and 141.74 (described above). Separate requirements are specified for systems which do not use filtration and systems which do use filtration.

1. Unfiltered Systems

Systems which do not use filtration are required to report to the State on a monthly basis whether they are meeting the treatment and monitoring requirements for avoiding filtration, for each month they serve water to the public. The report must include a summary of the results of source water monitoring for total or fecal coliforms (if the system monitors for both, only fecal coliforms must be reported) and turbidity, to demonstrate compliance with § 141.71(a). The specific items to be reported are listed in § 141.75(a)(1).

Each system that does not use filtration must report disinfection conditions monthly to demonstrate that: (1) It met the 99.9 percent *Giardia lamblia* cyst and 99.99 percent virus inactivation performance criteria; (2) there was not less than 0.2 mg/l disinfectant residual in the water supplied to the distribution system for more than four hours; (3) it met the requirement to have a detectable disinfectant residual or an HPC level less than or equal to 500/ml. The specific information about disinfection to be reported is listed in § 141.75(a)(2). After a system reports this information for one year, the State may waive most of the disinfection reporting requirements.

Other reporting requirements for systems which do not provide filtration include:

- An annual report which summarizes the system's compliance with all watershed control program requirements specified in § 141.71(b)(2).
- An annual report summarizing results of the on-site inspection which evaluated the effectiveness of the watershed control program and the reliability of the disinfection process, unless the on-site inspection was conducted by the State. If the inspection is conducted by the State, the State must provide a copy of its report to the public water system.
- Reports of waterborne disease outbreaks, turbidity measurements over 5 NTU, and failure to maintain a disinfectant residual of 0.2 mg/1 at the point of entry to the distribution system for more than 4 hours.

2. Filtered Systems

Public water systems which use filtration must report to the State on a monthly basis information regarding filtered water turbidity, disinfectant residual concentration in the water entering the distribution system, and disinfectant residual concentrations and/or HPC measurements in the distribution system. Turbidity reporting requirements vary depending upon the filtration technology used. Reporting requirements pertaining to disinfection requirements at the point of entry to the distribution system and within the distribution system are the same for filtered and unfiltered systems. The specific requirements are set out in § 141.75(b).

Systems must also report waterborne disease outbreaks, turbidity measurements over 5 NTU, and failure to maintain a disinfectant residual of 0.2 mg/1 at the point of entry to the distribution system for more than 4 hours.

D. Compliance

1. Compliance Transition with Current Turbidity Requirements

The existing (interim) NPDWR for turbidity, including the MCL in § 141.13 and the monitoring requirements in § 141.22 will continue in effect for unfiltered systems using a surface water source until 30 months after promulgation of this rule. However, there is an exception to this requirement. If the State determines that a system must filter (in writing, in accordance with section 1412(b)(7)(C)(iii)) earlier than 30 months from the promulgation date, that system must continue to comply with the interim turbidity rule until 48 months from promulgation or until filtration is installed, whichever is later. Thus, if the system installs filtration before 48 months from promulgation, it would comply with the interim turbidity requirements until 48 months from promulgation, and the turbidity requirements for filtered systems promulgated today in § 141.73 and § 141.74(c) would apply after that date.

It is important to note that, for awhile, unfiltered systems will be subject to both the interim turbidity MCL and monitoring requirements, and the turbidity monitoring requirements for unfiltered systems promulgated in § 141.74(b)(2), at the same time. This is appropriate because the monitoring required under § 141.22 is different from that required under § 141.74(b)(2): § 141.22, requires that samples be taken daily at a representative entry point to the distribution system, while § 141.74(b)(2) requires that samples be taken every four hours prior to the point of disinfectant application. Thus, the former is a measure of finished water, while the latter is a measure of source water quality.

The interim requirements for turbidity under §§ 141.13 and 141.22 will apply to filtered systems using a surface water source until 48 months after the promulgation of this rule. Beginning 48 months after the promulgation of this rule, the turbidity performance criteria for filtered systems in § 141.73 and the monitoring requirements under § 141.74(c), both promulgated today, will apply.

2. Systems Using a Surface Water Source (Not Including Systems Using a Ground Water Source Under the Direct Influence of Surface Water)

As required by SDWA, within 18 months following the promulgation of this rule, States must promulgate any regulations necessary to implement this rule. Under section 1413, these rules must be at least as stringent as those required by EPA. Within 30 months following promulgation of this rule, each State must determine which systems are required to install filtration. If filtration is required, it must be installed within 48 months following the promulgation of this rule. If it is not feasible for a system to install filtration within this time, the State may allow for a longer period under the exemption provisions of section 1416, as discussed in Section IV.G, below. Procedures for State implementation of today's rule appear in Section V, below.

As described above, today's rule specifies (a) conditions systems must meet to avoid filtration (and other criteria for unfiltered systems), and (b) requirements that apply to filtered systems. Regardless of whether the State complies with the statutory schedule for adopting the criteria and applying them to determine which systems must install filtration, each system using a surface water source must comply with one or the other, i.e., either the criteria for avoiding filtration and other requirements for unfiltered systems or the requirements for filtered systems, by the relevant statutory deadline. Thus, beginning 30 months after promulgation of this rule, the requirements for avoiding filtration

specified in § 141.71 (a) and (b) and the requirements of § 141.71(c) and § 141.72(a) go into effect unless the State already has determined that filtration is required; a system that fails to meet any one of the criteria for avoiding filtration in § 141.71 (a) and (b) must install filtration and comply with all the requirements for filtered systems (the general requirements in § 141.73 and the disinfection requirements in § 141.72(b)) within 48 months of promulgation. Likewise, beginning 30 months after promulgation, if a system fails to meet any one of the criteria for avoiding filtration, even if the system was meeting all the criteria up to that point, it must install filtration and comply with the requirements for filtered systems within 18 months of the failure. In either case, whenever a State determines that filtration is required, it may specify interim requirements for the period prior to installation of filtration treatment.

To obtain the information necessary to determine whether an unfiltered system is meeting the criteria for avoiding filtration in § 141.71 (a) and (b), the rule includes monitoring and reporting requirements for unfiltered systems (*see* §§ 141.74(b) and 141.75(a), respectively). These requirements go into effect 18 months after promulgation of this rule, unless the State has already determined that filtration is required.

In reviewing these data, it is up to the State to determine how it will weigh the data gathered during the first 30 months following promulgation in deciding whether filtration is required. Thus, for instance, a system may not meet the specified CT requirements for the first four months of monitoring (i.e., months 19–23), upgrade its disinfection practice and then begin meeting the CT values in subsequent months. In this case, the State could conclude that the system would be able to meet this criterion for avoiding filtration, even though the system did not meet the criterion 11 out of the 12 previous months, as specified in § 141.71(b)(1). In other words, the time periods specified in the criteria for avoiding filtration (e.g., six months for total coliforms, one year and ten years for turbidity, one year for CT requirements) do not begin until 30 months from the date of promulgation (unless the State specifies an earlier date).

All systems with filtration in place must meet the treatment technique requirements specified in § 141.73 (filtration criteria) and § 141.72(b) (disinfection criteria), and the monitoring and reporting requirements specified in §§ 141.74(c) and 141.75(b), respectively, beginning 48 months after promulgation.

The above compliance dates are different from what were proposed. Under the proposed rule, all monitoring, reporting, and treatment technique requirements for unfiltered and filtered systems would have gone into effect beginning 48 months after promulgation of this rule. EPA believes that this schedule would not have been consistent with the intent of the SDWA. First, EPA believes that the statutory schedule (i.e., States make filtration decisions within 30 months and systems install filtration 18 months later) contemplates that systems which meet the criteria for avoiding filtration will meet them beginning no later than 30 months from promulgation, since this is the date by which all filtration decisions are to be made. Accordingly, EPA changed the compliance date in the rule. Second, it is clear that States will need monitoring information to determine whether systems are meeting the criteria for avoiding filtration. Therefore, the final rule requires unfiltered systems to begin monitoring 18 months from promulgation (unless the State has already determined that filtration is required).

3. Systems Using a Ground Water Source Under the Direct Influence of Surface Water

As explained in the section on State Implementation, below, the State's program revisions to adopt this final rule must include procedures for determining, for each system in the State served by a ground water source, whether that source is under the direct influence of surface water. Within five and ten years following the promulgation of this rule (i.e., by June 29, 1994 and June 29, 1999 each State must determine which community and non-community public water systems, respectively, use ground water which is under the direct influence of surface water. EPA recommends that these determinations be made in conjunction with related activities required by other regulations (e.g., sanitary surveys pursuant to the final coliform rule, vulnerability assessments pursuant to the volatile organic chemicals rule, assessment requirements in the forthcoming disinfection rule for ground water systems). In addition, section 1428 of the Safe Drinking Water Act requires States to develop wellhead protection programs for ground-water supply wells. EPA-approved wellhead protection programs may contain methods and criteria for determining zones of contribution, assessments of potential contamination, and management of sources of contamination. These programs may be used as a partial basis for determining (a) whether a system is under the direct influence of surface water and (b) if direct influence exists, whether current watershed controls are adequate to meet the watershed control requirement for avoiding filtration (§ 141.71(b)(2)). Guidelines for developing and implementing a State wellhead protection program are found in "Guidelines for Applicants for State Wellhead Protection Program Assistance Funds under the Safe Drinking Water Act" (U.S. EPA, 1987d).

A system using a ground water source under the influence of surface water that does not have filtration in place must begin monitoring and reporting in accordance with §§ 141.74(b) and 141.75(a), respectively, to determine whether it meets the criteria for avoiding filtration in § 141.71 (a) and (b) beginning 18 months after promulgation or six months after the State determines that the ground water source is under the influence of surface water, whichever is later. Within 18 months following the determination that a system is under the direct influence of surface water, the State must determine, using the same criteria that apply to systems using a surface water source, whether the system must provide filtration treatment. (The 18-month period was derived by adding the six months until monitoring begins to the 12 months SDWA provides States to make the filtration decision for systems using a surface water source.) Beginning 30 months after promulgation of this rule, or 18 months after the determination that a system is under the direct influence of surface water, whichever is later, the criteria for avoiding filtration in § 141.71 (a) and (b) and the requirements for unfiltered systems in § 141.71(c) and § 141.72(a) go into effect, unless the State has determined that filtration is required. Thus, a system using a ground water source under the influence of surface water that fails to meet any one of the criteria for avoiding filtration after the relevant date must install filtration and comply with all of the requirements for filtered systems (the general requirements in § 141.73 and the disinfection requirements in § 141.72(b)) 48 months after promulgation of this rule, or within 18 months of the failure to meet the criteria for avoiding filtration, whichever is later. As with systems using a surface water source, subsequent failure to comply with any one of the criteria for avoiding filtration also requires the installation of filtration treatment. Thus, beginning 30 months after promulgation

or 18 months after the State determines that a system is using a ground water source under the direct influence of surface water, whichever is later, if that system fails to meet any one of those criteria (even if the system was meeting the criteria for avoiding filtration up to that point), it must install filtration and comply with the requirements for filtered systems within 18 months of the failure. As with systems using a surface water source, in reviewing the data collected by an unfiltered system using ground water under the influence of surface water, for the first 18 months following the determination, it is up to the State to determine how it will weigh the data in deciding whether filtration is required.

Any system using a ground water source that the State determines is under the direct influence of surface water that already has filtration in place at the time of the State determination must meet the treatment technique requirements specified in § 141.73 (filtration criteria) and § 141.72(b) (disinfection criteria) and the monitoring and reporting requirements specified in §§ 141.74(c) and 141.75(b), respectively, beginning 48 months after promulgation or 18 months after the State determination, whichever is later.

4. Strategies for Implementation

To comply with this final rule, a system that uses surface water and does not currently disinfect its water must begin disinfection, and possibly filtration. While the system is being evaluated to determine what treatment needs to be installed (e.g., disinfection without filtration; disinfection first and filtration later because of time differences needed for construction; or filtration and disinfection at the same time), the State may determine that interim measures to reduce risk to health (e.g., notice to consumers that water should be boiled before use or distribution of bottled water) might be appropriate.

Similarly, for systems which are already disinfecting, but do not meet one or more of the requirements for avoiding filtration, the State may determine that interim measures are necessary to reduce risk to health (e.g., maintaining more stringent disinfection conditions until filtration is installed).

Some systems already have filtration and disinfection in place. While many such systems are already in compliance with all the requirements of the rule, other systems will require significant upgrades in treatment to meet all the performance criteria. As discussed earlier, filtration without disinfection, with proper pretreatment where appropriate, can be expected to achieve 99 to 99.9 percent (2- to 3-log) removal of *Giardia* cysts and 90 to 99.9 percent (1- to 3-log) removal of viruses (Logsdon, 1987). Some disinfection will be necessary to supplement filtration so that the overall treatment achieves the minimum treatment requirements of the rule, i.e., 99.9 percent removal and/or inactivation of *Giardia* cysts and 99.99 percent removal and/or inactivation of viruses. To achieve these performance criteria with a substantial margin of safety, EPA recommends different minimum levels of disinfection, depending upon the filtration technology in place. Table IV–2 summarizes the level of *Giardia* cyst and virus removal that EPA recommends generally be assumed for different filtration technologies (assuming they are well-operated), and the corresponding recommended minimum levels of disinfection needed for such systems to meet the overall minimum performance requirements. CT values for achieving 1-log inactivation of *Giardia* cysts are indicated in Table IV–3. CT values to achieve 0.5-log inactivation are one-half those indicated in Table IV.3. Recommended CT values for achieving different levels of virus inactivation are indicated in Table IV–4.

TABLE IV–2. RECOMMENDED MINIMUM LEVEL OF DISINFECTION AND ASSUMED LOG REMOVALS BY FILTRATION METHOD

Treatment	Assumed log removals		Recommended minimum level of disinfection	
	Giardia	Viruses	*Giardia*	Viruses
Conventional	2.5	2.0	0.5	2.0
Direct filtration	2.0	1.0	1.0	3.0
Slow sand filtration	2.0	2.0	1.0	2.0
Diatomaceous earth filtration	2.0	1.0	1.0	3.0

TABLE IV–3.—CT VALUES FOR ACHIEVING 1-LOG INACTIVATION OF GIARDIA LAMBLIA [1]

	pH	Temperature			
		0.5 °C	5 °C	10 °C	15 °C
Free Chlorine [2]	6	49	35	26	19
	7	70	50	37	28
	8	101	72	54	36
	9	146	146	78	59
Ozone		0.97	0.63	0.48	0.32
Chlorine Dioxide		21	8.4	7.4	6.3
Chloramines (preformed)		1,270	730	620	500

[1] From 3/31/89 draft Guidance Manual. Values to achieve 0.5-log inactivation are one half those shown in the table.

[2] CT values will vary depending on the concentration of free chlorine. Indicated CT values are for 2.0 mg/l free chlorine. (For other free chlorine concentrations, *see* the final Guidance Manual.)

TABLE IV-4.—CT VALUES FOR ACHIEVING INACTIVATION OF VIRUSES AT PHS 6 THROUGH 9 [1]

	Log inactivation	Temperature			
		0.5 °C	5 °C	10 °C	15 °C
Free chlorine	2	6	4	3	2
	3	9	6	4	3
Ozone	2	0.9	0.6	0.5	0.3
	3	1.4	0.9	0.8	0.5
Chlorine Dioxide [2]	2	8.4	5.6	4.2	2.8
	3	25.6	17.1	12.8	8.6
Chloramines [3]	2	1,243	857	643	428
	3	2,063	1,423	1,067	712

[1] CT values for free chlorine, ozone, and chlorine dioxide include safety factors. CT values for chloramines are based on laboratory data using preformed chloramine to inactivate Hepatitis A and do not include a safety factor (Sobsey, 1988).

[2] CT values for chlorine dioxide were based on laboratory studies at pH 6 (Sobsey, 1988). Based on limited data, chlorine dioxide appears much more effective at higher pHs. Procedures for demonstrating if lower CT values may be appropriate will be included in the final Guidance Manual.

[3] CT values for chloramines are only applicable if chlorine is added prior to ammonia. Procedures for demonstrating that lower CT values are appropriate will be included in the final Guidance Manual.

Systems using chlorine with CT values that achieve the recommended minimum level of inactivation for *Giardia* cysts will also achieve the recommended minimum level of inactivation for viruses. However, for other disinfectants, depending upon the filtration technology in place, the CT values for achieving the recommended minimum level of virus inactivation may in some cases be higher than those necessary to achieve the minimum recommended level of *Giardia* cyst inactivation. Guidance for making these determinations will be included in the final Guidance Manual.

The degree of disinfection should be commensurate with the degree of potential pathogen contamination in the source water and the type of clarification and filtration. For example, the system should provide higher levels of disinfection (e.g., 99 or 99.9 percent inactivation of *Giardia* cysts) when there is evidence of significant *Giardia* cyst contamination in the source water. Guidelines for providing an appropriate level of disinfection as a function of source water quality conditions and the extent of treatment processes will be available in the final Guidance Manual.

E. Public Notification

On October 29, 1987, EPA promulgated regulations to revise the existing public notification requirements in 40 CFR 141.32 to implement the 1986 amendments to the public notification provisions in section 1414(c) of the Safe Drinking Water Act. These regulations specify general notification requirements, including the frequency, manner, and content of notices, and require the inclusion of EPA-specified health effects information in each public notice. The public notification regulations divide violations into two tiers based on the seriousness of the violation, with each tier having different public notification requirements. Tier 1 violations include violations of an MCL, a treatment technique requirement, or a variance or exemption schedule. Some Tier 1 violations are designated as violations posing an "acute" risk to health. Tier 2 violations include violation of a monitoring requirement, failure to comply with a testing procedure prescribed by a NPDWR, and operating under a variance or exemption. Under this rule, §§ 141.70, 141.71(c), 141.72, and 141.73 prescribe treatment technique requirements. Thus, violation of these requirements are classified as Tier 1 violations. Violations of § 141.74, which prescribes testing procedures and monitoring requirements, are classified as Tier 2 violations. Violations of § 141.75 (reporting requirements) do not require public notification.

All of the requirements of § 141.32, the general public notification requirements, including the manner and frequency of notification, apply to violations of this final rule. The mandatory language to be included in public notices for violations of the filtration and disinfection requirements of this rule (i.e., §§ 141.70, 141.71(c), 141.72, and 141.73), including an acute violation (i.e., a waterborne disease outbreak in an unfiltered supply), is specified below:

Microbiological contaminants (for use when there is a violation of the treatment technique requirements for filtration and disinfection in Subpart H of this part). The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that the presence of microbiological contaminants are a health concern at certain levels of exposure. If water is inadequately treated, microbiological contaminants in that water may cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and any associated headaches and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA has set enforceable requirements for treating drinking water to reduce the risk of these adverse health effects. Treatment such as filtering and disinfecting the water removes or destroys microbiological contaminants. Drinking water which is treated to meet EPA requirements is associated with little to none of this risk and should be considered safe.

The above mandatory public notification language was changed from what was proposed. Types of disease, namely hepatitis, giardiasis, and gastroenteritis, which might be caused by consumption of inadequately treated water, have been deleted. Also, wording has been added which indicates that symptoms which may be associated with consumption of inadequately treated water may be caused by other factors not associated with drinking water. These changes were made in response to public comments which expressed concern that the general public would not be familiar with disease names such as giardiasis and gastroenteritis, and that most of the symptoms mentioned in the notice are so common that the water treatment plant might be considered responsible without justification.

F. Variances

Section 1415 allows States to grant variances from national primary drinking water regulations under certain conditions. However, section 1412(b)(7)(C)(ii) of the Safe Drinking Water Act states that, in lieu of the variance provisions of section 1415, EPA is to specify criteria by which States will determine which public water systems will be required to filter. This notice promulgates these filtration criteria.

Accordingly, the rule does not permit variances from the filtration requirements. As for the disinfection requirements in this rule, due to the acute nature and high risk associated with poor disinfection of surface waters, no variances are allowed.

C. Exemptions

Section 1416 of the Safe Drinking Water Act allows a State to exempt any public water system within its jurisdiction from any treatment technique requirement imposed by a national primary drinking water regulation upon a finding that:

1. Due to compelling factors (which may include economic factors), the public water system is unable to comply with the treatment technique requirement;
2. The public water system was in operation on the effective date of the treatment technique requirement or, for a system that was not in operation by that date, only if no reasonable alternative source of drinking water is available to the new system; and
3. The granting of the exemption will not result in an unreasonable risk to health.

If a State grants a public water system an exemption, the State must prescribe, at the time the exemption is granted, a schedule for:

1. Compliance (including increments of progress) by the public water system with each treatment technique requirement with respect to which the exemption was granted; and
2. Implementation by the system of such control measures as the State may require during the period the exemption is in effect.

Before prescribing a schedule, the State must provide notice and opportunity for a public hearing on the schedule. The schedule prescribed must require compliance by the public water system with the treatment technique requirement as expeditiously as practicable, but in no case later than one year after the exemption is issued (except that, if the system meets certain requirements, the final date for compliance may be extended for a period not to exceed three years from the date the exemption is granted). For systems serving fewer than 500 service connections, and meeting certain additional requirements, the State may renew the exemption for one or more additional two-year periods.

Under this rule, no exemptions are allowed from the requirement to provide disinfection for surface water systems, for the same reason variances are not allowed. However, exemptions are available to reduce the degree of disinfection required. Exemptions from the filtration requirements are available as well. For example, under certain conditions, it might be appropriate for an unfiltered system to receive an exemption, for a limited time, if it achieves only 99 percent inactivation of *Giardia lamblia* cysts (i.e., it did not meet the 99.9 percent inactivation requirement). Guidance for determining conditions under which an exemption might be appropriate is provided in the final Guidance Manual.

V. State Implementation of the Surface Water Treatment Requirements

A. General

Section 1413 of the Safe Drinking Water Act establishes requirements a State must meet to have primary enforcement responsibility for public water systems ("primacy"). These include: (1) Adopting drinking water regulations no less stringent than the NPDWRs in effect under sections 1412(a) and 1412(b) of the Act; (2) adopting and implementing adequate procedures for enforcement; (3) keeping records and making such reports with respect to its activities as EPA may require by regulation; (4) issuing variances and exemptions (if allowed at all by the State) under conditions no less stringent than allowed by sections 1415 and 1416; and (5) adopting and being able to implement an adequate plan for the provision of safe drinking water under emergency situations.

40 CFR Part 142 sets out the specific program implementation requirements for States to obtain primacy for the public water system supervision (PWSS) program as authorized under Section 1413 of SDWA. EPA first promulgated these regulations on January 20, 1976. Since 1976, however, much has happened in the PWSS program, and portions of the implementation regulations at 40 CFR Part 142 have become outdated. In response, on August 2, 1988, the Agency proposed revisions to 40 CFR Part 142, Subpart B which take into account the program's evolution since 1976, as well as the new legislative mandates (53 FR 29194). These regulations, when promulgated, will specify the procedures and timing for States to follow to obtain approval of program changes to adopt new or revised regulations that EPA promulgates.

When today's regulations for surface water treatment were proposed on November 3, 1987 (52 FR 42178), the schedule for revising the implementation regulations (40 CFR Part 142) was not known. Consequently, the implementation portion of the proposed surface water treatment requirements included a complete list of requirements for States to meet to obtain approval of their program revisions, including both general requirements applicable to all program revisions (e.g., regulations that are no less stringent than the NPDWRs that EPA promulgates in Part 141), as well as specific requirements applicable only to the surface water treatment provisions. However, EPA expects to promulgate the revised implementation regulations shortly. These implementation regulations will specify procedures, timing, and other general requirements a State must meet to retain primary enforcement responsibility. For instance, these final rules will make it clear that each time EPA adopts (or revises) an NPDWR under section 1412, primacy States must adopt drinking water regulations that are no less stringent than the new regulations. Therefore, today's amendments to Part 142 only address "special primacy requirements," i.e., requirements that are unique to the surface water treatment requirements promulgated in Part 141; general primacy requirements applicable to all NPDWRs are not addressed in today's amendment of 40 CFR Part 142.

In some respects, the State implementation of the regulations in 40 CFR Part 141, Subpart H—Filtration and Disinfection, is different from implementation of other NPDWRs. The surface water treatment requirements promulgated today consist of both objective, uniform criteria and criteria that provide the primacy State broad discretion to decide whether to implement them (and if so, how), considering the objectives of the regulations and the variability encountered in surface water treatment throughout the diverse geographical areas of the United States

As a condition of primacy, States must promulgate regulations that incorporate requirements that are no less stringent than these objective criteria in the surface water treatment requirements. Since the general primacy rule will require all State program revisions to include requirements that are no less stringent than Federal requirements, today's amendments to Part 142 do not list each provision of the surface water treatment requirements for which the State must adopt a corresponding revision which is no less stringent. (However, to assist States developing program revisions to adopt today's regulations, Section V.B.1. below identifies such provisions.)

Where it was not possible to develop uniform national criteria or where States

are provided flexibility to modify the national criteria to account for site-specific circumstances, the surface water treatment requirements give the States discretion to adopt appropriate requirements. For purposes of implementation, EPA has divided these areas of State discretion into two categories. For items in the first category, the State must demonstrate that it has adopted enforceable requirements in the form of State rules, regulations, and/or permit requirements. For items in the second category, the State need only describe the practices or procedures it will use to implement those parts of its program. The specific items in these two categories are listed in Sections V.B.2 and 3 below.

Where the State must have enforceable rules, regulations, and/or permit requirements, i.e., elements in the first category, EPA review of this portion of the State program revision will generally be limited to a determination that the State requirements are enforceable, rather than a detailed evaluation of the content of the requirements per se. For items in the second category, where the State only is required to describe the practices or procedures it will use in exercising the discretion provided in the surface water treatment requirements, EPA review of the State program revision will generally be even more limited. It will consider whether the State practices or procedures are clear and unambiguous. In both cases, however, EPA will consider whether the State's provisions can be reasonably expected to accomplish the objectives of the surface water treatment requirements.

B. Specific Primacy Requirements for States to Adopt 40 CFR Part 141 Subpart H—Filtration and Disinfection

The three types of provisions States must adopt are described in greater detail below.

1. General Primacy Requirements—State Requirements Must Be No Less Stringent than Federal Requirements

As explained above, for those portions of the surface water treatment requirements promulgated today which establish objective criteria, primacy States must adopt equivalent, i.e., no less stringent, requirements. Although these objective criteria are not listed in the revisions to Part 142 for the reasons described in the previous section, EPA has, for convenience, summarized these criteria below. (Some of these criteria allow exceptions on a case-by-case basis, as described in Part 141, Subpart H. These exceptions are listed in § 142.16(b)(2) (iii) and (iv) of the rule and Section V.B.3 of this preamble. For each provision that allows exceptions, States may choose to simply adopt the requirement as listed here (allowing for exceptions), or permit the exceptions described in the later section.) At a later date, specific guidance will be developed and provided to States to assist them in preparing their program revisions.

(a) Section 141.2—New definitions.

(b) Section 141.32(a)(1)(iii)(D)—Waterborne disease public notification requirements.

(c) Section 141.32(e)(10)—Mandatory health effects language for microbiological contaminants.

(d) Section 141.70(a)(1)—Requirement for 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts.

(e) Section 141.70(a)(2)—Requirement for 99.99 percent removal and/or inactivation of viruses.

(f) Section 141.70(b)—Compliance requirements for public water systems that filter and systems that do not filter.

(g) Section 141.70(c)—Requirement that public water systems be operated by qualified personnel.

(h) Section 141.71—Deadlines for installation of filtration and compliance with filtration requirements for systems using a surface water source or ground water under the direct influence of surface water which do not meet all the requirements for avoiding filtration; deadlines for meeting criteria for avoiding filtration for systems which choose not to filter.

(i) Section 141.71(a)—Source water quality conditions for public water systems that choose to avoid filtration, including:

(1) Section 141.71(a)(1)—Coliform limits.

(2) Section 141.71(a)(2)—Turbidity limits.

(j) Section 141.71(b)—Site-specific conditions for public water systems that wish to avoid filtration, including:

(1) Section 141.71(b)(1)—Disinfection compliance requirements.

(2) Section 141.71(b)(2)—Requirement to have, and mandatory elements of, a watershed control program.

(3) Section 141.71(b)(3)—Requirement that system have an annual on-site inspection that includes the elements specified.

(4) Section 141.71(b)(4)—Requirement that system has not been identified as a source of a waterborne disease outbreak (or, if it was, that the system has been sufficiently modified to prevent recurrence).

(5) Section 141.71(b)(5)—Requirement that system be in compliance with the total coliform MCL for 11 of the last 12 consecutive months.

(6) Section 141.71(b)(6)—Requirement that system comply with total trihalomethane monitoring and MCL requirements.

(k) Section 141.71(c)—Treatment technique requirements whose failure does not trigger filtration for public water systems which do not filter.

(l) Section 141.72—Deadlines for compliance with disinfection requirements for systems that filter and those that do not.

(m) Section 141.72(a)—Disinfection requirements for systems which do not filter, including:

(1) Section 141.72(a)(1)—Requirement for 99.9 and 99.99 percent removal of *Giardia lamblia* cysts and viruses, respectively, as determined by CT calculations;

(2) Section 141.72(a)(2)—Requirement for either redundant components or automatic shutoff;

(3) Section 141.72(a)(3)—Requirement that water entering the distribution system have at least a 0.2 mg/l disinfectant residual concentration; and

(4) Section 141.72(a)(4)(i)—Requirement for a detectable residual or certain HPC levels in the distribution system.

(n) Section 141.72(b)—Disinfection requirements for systems which filter, including:

(1) Section 141.72(b)(1)—Requirement for 99.9 and 99.99 percent removal of *Giardia lamblia* cysts and viruses, respectively, by the combined treatment processes of the system;

(2) Section 141.72(b)(2)—Requirement that water entering the distribution system have at least 0.2 mg/l disinfectant residual concentration; and

(3) Section 141.72(b)(3)(i)—Requirement for a detectable residual or certain HPC levels in the distribution system.

(o) Section 141.73—Requirements (including deadlines for compliance) for systems that provide filtration treatment including:

(1) Section 141.73—Deadlines for installation of filtration equipment;

(2) Section 141.73(a)—Turbidity limits for systems using conventional or direct filtration;

(3) Section 141.73(b)—Turbidity limits for systems using slow sand filtration;

(4) Section 141.73 (c)—Turbidity limits for systems using diatomaceous earth filtration; and

(5) Section 141.73(d)—If the State allows alternative filtration technologies, the requirement that such technologies, at a minimum, meet the

turbidity limits for systems using slow sand filtration.

(p) Section 141.74(a)—Requirement that only EPA-approved analytical methods be used to demonstrate compliance; requirement that analyses for total coliforms, fecal coliforms, and heterotrophic bacteria be conducted by certified laboratories, and that remaining measurements (pH, temperature, turbidity, residual disinfectant concentration) be made by a party approved by the State.

(q) Section 141.74(b)—Monitoring requirements for systems that do not provide filtration treatment, including:

(1) Section 141.74(b)—Deadlines for compliance with monitoring requirements;

(2) Section 141.74(b)(1)—Coliform monitoring requirements;

(3) Section 141.74(b)(2)—Turbidity monitoring requirements;

(4) Section 141.74(b)(3)—Monitoring requirements and methods for calculating CT values;

(5) Section 141.74(b)(4)—Method for calculating inactivation ratios;

(6) Section 141.74—Tables 1.1–1.6, 2.1, and 3.1 (CT values);

(7) Section 141.74(b)(5)—Disinfectant residual monitoring requirements for water entering the distribution system; and

(8) Section 141.74(b)(6)(i)—Disinfectant residual monitoring requirements for water in the distribution system.

(r) Section 141.74(c)—Monitoring requirements for systems that provide filtration treatment, including:

(1) Section 141.74(c)—Deadlines for compliance with monitoring requirements;

(2) Section 141.74(c)(1)—Turbidity monitoring requirements;

(3) Section 141.74(c)(2)—Disinfectant residual monitoring requirements for water entering the distribution system; and

(4) Section 141.74(c)(3)(i)—Disinfectant residual monitoring requirements for water in the distribution system.

(s) Section 141.75(a)—Reporting requirements for systems which do not filter, including:

(1) Section 141.75(a)—Deadlines for compliance with reporting requirements;

(2) Section 141.75(a)(1)—Source water quality reporting requirements;

(3) Section 141.75(a)(2)—Disinfection reporting requirements;

(4) Section 141.75(a)(3)—Watershed control program reporting requirements;

(5) Section 141.75(a)(4)—On-site inspection reporting requirements; and

(6) Section 141.75(a)(5)—Reporting requirements when there is a waterborne disease outbreak, certain turbidity violations, and failure to maintain a disinfectant residual entering the distribution system.

(t) Section 141.75(b)—Reporting requirements for public water systems that filter, including:

(1) Section 141.75(b)—Deadlines for compliance with reporting requirements;

(2) Section 141.75(b)(1)—Turbidity reporting requirements;

(3) Section 141.75(b)(2)—Disinfection reporting requirements; and

(4) Section 141.75(b)(3)—Reporting requirements when there is a waterborne disease outbreak, certain turbidity violations, and failure to maintain a disinfectant residual entering the distribution system.

(u) Section 142.64—Limits on State issuance of variances and exemptions.

(v) SDWA section 1412(b)(7)(C)(ii)—Requirement for procedures to provide notice and opportunity for public hearing for determination of whether a public water system shall adopt filtration.

2. Special Primacy Requirements—State Requirements Must Be Enforceable

State program revisions to adopt the surface water treatment requirements promulgated today in Part 141, Subpart H must include enforceable requirements that specify design and operating conditions for all disinfection and filtration treatment processes and/or equipment used by public water systems to comply with 40 CFR 141.70, 141.71, 141.72 and 141.73. Alternatively (or in combination with enforceable design and operating conditions), the State may establish a procedure for setting enforceable design and operating requirements on a system-by-system basis (e.g., a permit system).

3. Special Primacy Requirements—State Must Establish Practices or Procedures

An application for approval of a State program revision must describe the practices or procedures that the State will use to implement provisions of the surface water treatment requirements that provide the State flexibility with respect to how the objectives of the regulation are to be achieved. Examples include the authority to modify certain monitoring, analytical, performance, and reporting requirements; approve alternate disinfection processes or technologies; determine whether the combination of treatments provided achieve the required level of removal and/or disinfection; establish qualifications for public water system operators and parties conducting on-site inspections; and determine which systems supplied by ground water are under the direct influence of surface water.

It is important to note that these provisions take two forms: Provisions in Part 141, Subpart H, that give the States full implementation discretion and provisions that allow the State to modify the stated requirements under certain circumstances if the State so chooses. The corresponding primacy requirements depend on the category of the provision.

For each of the provisions in § 142.16(b)(2)(i), which fall in the first category, State program revisions must include a description of the practices and procedures (or regulations, if they cover these items) that explain how the State will exercise its discretion. Likewise, States which allow public water systems to avoid filtration by meeting the requirements of § 141.71 must also submit the practices and procedures (or regulations) describing how they will exercise their discretion for each of the provisions listed in § 142.16(b)(2)(ii).

Provisions in the second category are listed in § 142.16(b)(2)(iii) (which are options available to all States) and in § 142.16(b)(2)(iv) (which are options available to States that allow systems to avoid filtration by meeting the requirements of § 141.71). For each of the provisions in this second category, the State needs to submit procedures and practices (or regulations) that explain how it will exercise the discretion allowed only for those options it plans to exercise. For instance, if the State does not plan to set alternative turbidity limits under § 141.73 (a)(1) or (b)(1), its program revision need not address this provision, i.e., it need not submit anything under § 142.16(b)(2)(iii)(C).

C. State Reporting and Recordkeeping Requirements

Today's notice amends 40 CFR Part 142 to require States with primary enforcement responsibility to retain records and report information to EPA sufficient to ensure adequate oversight of the States' activities to implement the surface water treatment requirements. Specifically, States must:

(1) Retain for not less than one year records of microbiological analyses, i.e., analyses for total coliforms, fecal coliforms, and heterotrophic plate count (in both finished water and source water), in a form which makes possible comparison with the total coliform, fecal coliform, and heterotrophic plate count limits specified in 40 CFR 141.63, 141.71, and 141.72.

(2) Retain for not less than one year records of disinfectant residual monitoring and other parameters necessary to document disinfection

effectiveness in accordance with § 141.72. Reports submitted by public water systems must comply with § 141.75.

(3) Retain for not less than one year records of turbidity monitoring necessary to document filtration effectiveness in accordance with § 141.73. Reports submitted by public water systems must comply with § 141.75.

(4) Retain, for specified periods, records of determinations made by the State where the State has exercised discretionary authority allowed by § 142.16(b). This discretionary authority includes modified monitoring, analytical, performance, and reporting requirements, as well as authority to qualify operators or approve on-site inspectors. Where such decisions are made on a system-by-system or case-by-case basis, the State must keep a record in its files which documents that decision. A State is required to provide a formal, written notice of certain determinations to the system (e.g., reduced monitoring and substitute turbidity limits), and it may want to do so in other instances to prevent confusion on the part of the system or other party. Appropriate cases could include notification of qualified operators and approved on-site inspectors. A list of determinations for which these records must be kept is included in the rule promulgated today in § 142.14(a)(4)(ii).

(5) Retain indefinitely records of any determination under § 141.71 that a public water system using a surface water source or a ground water source under the direct influence of surface water is not required to provide filtration treatment.

(6) Report annually the name and PWS identification number of each public water system using a surface water source or a ground water source under the direct influence of surface water that the State has determined need not provide filtration treatment, and the date that the State made the determination for each such system.

(7) Report annually the name and PWS identification number and date of each determination of each public water system supplied by a surface water source or a ground water source under the direct influence of surface water that the State determined is providing adequate disinfection even if the system is not meeting the criteria for residual disinfectant concentration specified by § 141.72(a)(4)(i) or 141.72(b)(3)(i).

(8) Notify EPA within 60 days of the end of each calendar quarter of any determination that a public water system using a surface water source or a ground water source under the direct influence of surface water is not required to provide filtration treatment.

D. EPA Oversight of State Decisions Regarding Filtration Requirements

EPA intends to periodically review States' decisions as to whether public water systems supplied by a surface water source or a ground water source under the direct influence of surface water are required to provide filtration. EPA will use procedures similar to those spelled out in Section 1415(a)(1)(F) of the Act for EPA oversight of variances issued by States. EPA considers this to be an appropriate procedure for review of filtration decisions since (1) the Act links filtration determinations and decisions on variances by requiring EPA to specify "in lieu of the variance requirements of Section 1415" procedures by which States are to determine which public water systems must adopt filtration, and (2) the filtration and variance decisions are similar in nature. Essential elements of this procedure which appears at 40 CFR Part 142, Subpart I include: (1) Reporting by States of filtration decisions; (2) periodic review, preceded by **Federal Register** notice, of State filtration decisions by EPA; (3) notice to the State if the Administrator finds the State has abused its discretion in making filtration decisions; (4) an opportunity for the State to take corrective action; (5) a public hearing conducted by a hearing officer to review testimony; and (6) a final decision by the Administrator that upholds or rescinds the finding that the State has abused its discretion. In the event the Administrator finds that the State has abused its discretion, (s)he would revoke decisions with regard to filtration made by the State and/or revoke any compliance schedule approved by the State.

It is important to note that EPA need not undergo these procedures prior to taking an enforcement action against a specific public water system for failure to comply with today's rule, if, for instance, the State has determined that the system is not required to filter, but the system is not complying with the requirements for avoiding filtration. Likewise, promulgation of the procedures in Part 142, Subpart I does not preclude EPA from using other appropriate means to ensure that the State exercises its discretion properly. Such measures may include grant conditions or initiation of primacy revocation procedures when there is evidence that a State is not making appropriate filtration decisions.

E. Response to Comments on Proposed Requirements for State Implementation of the Surface Water Treatment Requirements

Commenters on the proposed surface water treatment requirements and the associated proposed implementation regulations at 40 CFR 142.16 (52 FR 42178, November 3, 1987) generally focused on the requirements addressed to public water systems in the primary regulation (i.e., the Part 141 provisions) rather than the proposed State implementation requirements. However, some commenters did express concern that the proposed SWTR implementation regulations would require them to adopt enforceable regulations, which EPA could disapprove, without EPA having to propose and receive comment on the appropriate criteria for approving such revisions. Some commenters also expressed concern that EPA, through the primacy review process, would attempt to establish uniform national criteria for treatment requirements that would not account for local variability. Finally, some commenters were concerned that the proposed amendments to § 142.17 (special primacy requirements, promulgated today in § 142.16) implied that States must adopt provisions to exempt some systems using surface water sources from the filtration requirements. Other commenters suggested that EPA was asking for too much information from both systems and States.

In the final rule, EPA has revised the State implementation requirements in response to commenters' concerns. First, EPA expects to promulgate revised general implementation regulations shortly; these revised provisions will establish standard procedures, timing, and other requirements States must meet to revise their programs following promulgation by EPA of new or revised national primary drinking water regulations. Accordingly, the general State program revision requirements in the November 3, 1987, notice are not included in today's final rule. Since the forthcoming amendments of the primacy rule will require that, whenever EPA adopts new or revised NPDWRs, States adopt requirements no less stringent than these NPDWRs, it is not necessary to list each new requirement promulgated in Part 141 in Part 142 as well. As a result, the list of special primacy requirements to adopt this regulation has been significantly reduced. Special primacy requirements are limited to those included in 40 CFR

142.16(b), promulgated today (and described earlier).

Today's implementation provisions (in both the regulation and preamble) make it clear that EPA is not establishing uniform national treatment requirements through the program revision process. States are given a great deal of discretion in implementation; many provisions in the final rule may be modified by the States in appropriate circumstances. Also, the language promulgated in § 142.16(b)(2) clearly indicates that States have the option to require that all public water systems using surface water sources or ground water directly influenced by surface water provide filtration treatment.

Finally, the amount of public water system reporting to States has been reduced to the lowest level practicable. This reduces the State recordkeeping requirements as well. In addition, the number and frequency of reports States are required to provide EPA has been reduced. Those that remain are considered essential for EPA to perform its oversight function.

VI. Economic Analysis

Under Executive Order 12291, EPA must judge whether a regulation is "major" and therefore subject to the requirements of a Regulatory Impact Analysis. This action constitutes a "major" regulatory action because it will have a major financial or adverse impact on the regulated community of over $100 million per year. Therefore, EPA prepared a Regulatory Economic Impact Analysis for both the proposed and final rules and submitted them to the Office of Management and Budget for review. In the draft RIA (USEPA, 1987c), the capital cost was estimated to be $2.0 billion, and the annualized cost, $338 million.

In response to public comments on the estimated cost of complying with the rule as proposed, EPA made several changes in its estimating methodology which resulted in a significant increase in the projected compliance cost. The nature of these changes, and their corresponding effects on the original cost estimates, are described below.

1. *Land, piping, and pumping costs in newly installed filtration plants.* These items were not included in the earlier analysis because they are highly site-specific. Including these costs increases EPA's previous estimate by $695 million for capital, or $121 million/year on an annualized basis. It should be borne in mind, however, that the costs used are extremely rough estimates.

2. *Disinfection for filtered systems.* At the time of proposal, EPA did not include any costs for upgrading disinfection practices because the Agency believed that most systems were already complying with disinfection standards similar to those in the proposed rule (e.g., the "Ten-State Standards"). Subsequently, EPA learned that, in fact, many systems will need to upgrade their disinfection practice to comply with the disinfection requirements of this rule, and has adjusted its cost estimate accordingly. EPA expects systems to expend an estimated $258 million in capital costs for improved disinfection. On an annualized basis, this amounts to an additional $27 million/year.

Other costs which commenters suggested EPA should include in the estimate have not been estimated, as explained below:

1. *Covering open distribution reservoirs.* Apparently, some commenters thought this was a requirement of the proposed rule. This is incorrect. Such a requirement was not part of the proposed rule and is not required in the final rule, either. Therefore, the cost of covering reservoirs is not considered to be a compliance cost imposed by this rule.

2. *Preparation of environmental impact statements and mitigation of environmental impacts.* Costs for these items are highly site-specific. To project them with any degree of accuracy would require an engineering cost study of each system in the U.S. Clearly, this is not possible. Also, relative to other costs, these costs are not expected to be significant. Therefore, the final RIA (USEPA, 1989a) does not assess these costs.

3. *Installation of meters and correction of leaks in the distribution system.* EPA agrees that, in systems experiencing high rates of leakage, it may well make good economic sense to correct excessive leaks in view of the higher cost of produced water resulting from compliance with this rule. Likewise, unmetered systems tend to encourage extravagant use and the additional costs imposed by this rule might cause operators to feel that the provision of unmetered water can no longer be justified. Nevertheless, the correction of leaks and installation of meters are economy measures and are not required to achieve compliance with the rule. Therefore, their cost is not properly attributable to these requirements. (Even if such costs were attributable to the rule, they should be offset by the savings from the reduction in leakage and wasteful use. In fact, it is conceivable that, over the long run, such savings could largely offset the cost of compliance with this rule.) Finally, the cost of correcting leaks is highly site specific and EPA knows of no way to make a reasonably accurate estimate of such costs other than performing engineering studies at each affected location, which clearly is not feasible. Based upon these considerations, EPA has not included any costs for leak correction and meter installation.

The following sections summarize EPA's detailed cost analysis provided elsewhere (USEPA, 1987c, 1989a).

A. Total Cost of the Final Rule

The filtration and disinfection requirements of this rule will impose costs on four groups of public water systems using surface water sources:

1. An estimated 1,346 community water systems that are currently unfiltered.

2. An estimated 1,536 non-community water systems that are currently unfiltered (non-community water systems include systems serving transient and non-transient populations).

3. An estimated 4,611 community water systems that are currently filtered.

4. An estimated 2,308 non-community water systems that are currently filtered.

There are, therefore, an estimated total of 2,882 water systems that are currently unfiltered and 6,919 systems that are currently filtered which will be affected by this rule. All 2,882 unfiltered surface water systems will incur some costs under this rule. However, systems that meet the specified requirements for avoiding filtration will not incur the costs associated with installing filtration.

Of the estimated 6,919 filtered surface water systems, EPA estimates that about 5,128 will incur total annualized costs of $113 million per year to upgrade their systems from their current level of performance to meet the new turbidity requirements. Were all of them in compliance with the existing (interim) national primary drinking water regulations at this time, the annualized cost to the nation would be only $95 million per year. However, EPA estimates that 1,409 systems are not. Thus, these systems will have to do more than those in compliance with the interim rule to meet the new requirements. For these deficient systems, the additional cost of meeting the new regulations is $18 million per year. The annualized cost of $95 million is considered to be the "incremental" cost of this rule because it is based on a comparison between the cost of complying with the new requirements and the cost of complying with the interim regulations (assuming 100 percent compliance). The annualized

cost of $113 million is considered to be the "total" cost of today's rule because it takes into account the additional expense to be incurred by systems not presently complying with the interim regulations.

The same 6,919 filtered water systems will also be subject to the disinfection performance requirements. As discussed earlier, at the time of proposal, these costs were not believed to be significant and thus were not included in the estimates. It is now estimated that approximately 1,200 of these systems will have to upgrade their disinfection practices, at a cost of $27 million/year. EPA also has estimated compliance costs for systems using a ground water source under the direct influence of surface water. These systems will incur capital costs of $164 million and annualized costs of $11 million per year.

All systems subject to this rule, except those which are able to avoid filtration, will incur incremental annualized monitoring costs of $17 million. The total annualized monitoring cost of $18 million takes into account the additional expense to be incurred by systems not currently complying with the interim monitoring regulations. Monitoring costs for systems that meet the criteria for avoiding filtration were counted as costs of treatment for unfiltered systems. States will incur annualized implementation costs of $12 million.

The estimated costs of the proposed and final surface water treatment requirements are presented in Table VI-1.

TABLE VI-1.—PROJECTED COST OF THE PROPOSED AND FINAL SURFACE WATER TREATMENT REQUIREMENTS

Cost category	Costs under the proposed rule		Current estimate	
	Capital cost ($mil)	Annualized cost ($mil/yr.)	Capital cost ($mil)	Annualized cost ($mil/yr.)
Treatment Requirements				
Unfiltered Systems (installing or avoiding filtration)	1613	216	2308	337
Filtered Systems				
Turbidity Reduction				
Incremental	333	95	333	95
Total	NA	NA	403	113
Disinfection	0	0	258	27
Surface-Influenced Ground Water Systems	0	0	164	11
Monitoring Requirements				
All Surface Systems Except Those Able to Avoid Filtration [1]				
Incremental	58	20	30	17
Total	NA	NA	30	18
State Program Costs	0	7	0	12
Cost of Rule				
Incremental	2004	338	3093	499
Total	NA	NA	3163	518

NA=not applicable.
[1] For the projected 16 percent of systems able to avoid filtration, the monitoring costs associated with meeting the criteria for avoiding filtration are included as costs of treatment for unfiltered systems.

B. Concepts of Cost Analysis

Capital, operating, and annualized costs for individual filtration and disinfection technologies appear in "Technologies and Costs for the Removal of Microbiological Contaminants from Potable Water Supplies" (USEPA, 1988b). The annualizing procedure used in that document is intended to reflect the actual financing cost that a typical water system might face in capital markets, i.e., it is an estimate of the "market" cost. However, the total annual cost estimate of $518 million discussed above (see Table VI-1) is intended to represent the total "social" cost to the nation for purposes of making benefit/cost comparisons. It is computed using a different discount rate. The discount rate used to assess "market" cost is ten percent. This is made up of three components: (1) A risk premium (reflecting the market's assessment of the risk of default); (2) an inflation premium (reflecting the market's expectations about the economy); and, (3) the true carrying cost of capital (the time value of money). The first two components are financial concepts while the third is both a financial and an economic concept. The "social" discount rate consists only of the third of these three components because the benefits to which costs are being compared are a risk-free, inflation-free economic concept. Three percent was selected for use in these analyses.

An analysis of costs based on the financing options a typical system might face in capital markets appears in Figure VI-1.

C. Costs of Compliance for Currently Unfiltered Surface Water Systems

EPA based its estimates of the number of community and non-community water systems that are currently unfiltered on a survey conducted by the Association of State Drinking Water Administrators (ASDWA, 1986). EPA estimated the total national cost of compliance for the 2,882 currently unfiltered systems using a straightforward procedure for forecasting likely compliance choices. Predicted compliance choices for the 2,867 systems which each serves fewer than 100,000 people, appear in Table VI-2.

TABLE VI-2.—PREDICTED COMPLIANCE CHOICES FOR UNFILTERED SYSTEMS

Number of systems	Projected action
457	Meet requirements for avoiding filtration.
899	Switch to an alternate water source (ground or purchased).
221	Install a package treatment plant.
58	Install conventional treatment.
89	Install direct filtration.
115	Install diatomaceous earth filtration.
990	Install slow sand filtration.
38	Install ultrafiltration.

EPA based the forecasts of compliance choices largely on the comparative costs of the different options. The Agency predicted that slow sand filtration, switching to an alternate source, and package treatment plants would be popular solutions due to the relatively low costs of these technologies compared to other technologies and the preponderance of small water systems among those affected (over 90 percent of currently unfiltered water systems serve fewer than 10,000 people).

It is important to note that a large proportion of total costs for currently unfiltered systems is attributable to a small group of fifteen unfiltered systems which each serves more than 100,000 people. These fifteen systems account for approximately 40 percent of the $518 million total annualized cost. However, these fifteen systems also serve approximately 16 million of the estimated 21.4 million people exposed to unfiltered surface water (75 percent).

As discussed above, the cost estimates presented with the proposed rule did not include certain site-specific cost elements, such as land costs and costs of additional piping and pumping, due to the difficulty of assessing these site-specific factors. EPA believes these costs could increase the total cost of installing filtration on the order of $695 million, or $121 million per year on an annualized basis, over the original estimate.

Figure VI–1 illustrates the system level market costs of complying with the filtration requirement for system size categories serving fewer than 100,000 persons. The costs shown represent the approximate high and low extremes of the cost of installing filtration. For systems serving fewer than 10,000 people, EPA used slow sand filtration as the basis for the low-cost estimate and package treatment as the basis for the high-cost estimate. For systems serving between 10,000 and 100,000 people, EPA used direct filtration to represent the low-cost case and conventional treatment for the high-cost estimate. System level costs for installing filtration in the 15 large systems, i.e., the systems which serve more than 100,000 persons and not represented in Figure VI–1, were based on a case-by-case assessment of the actual types and sizes of filter plants that might be built in those cities. These costs ranged from $0.37 to $0.72 per thousand gallons of water produced.

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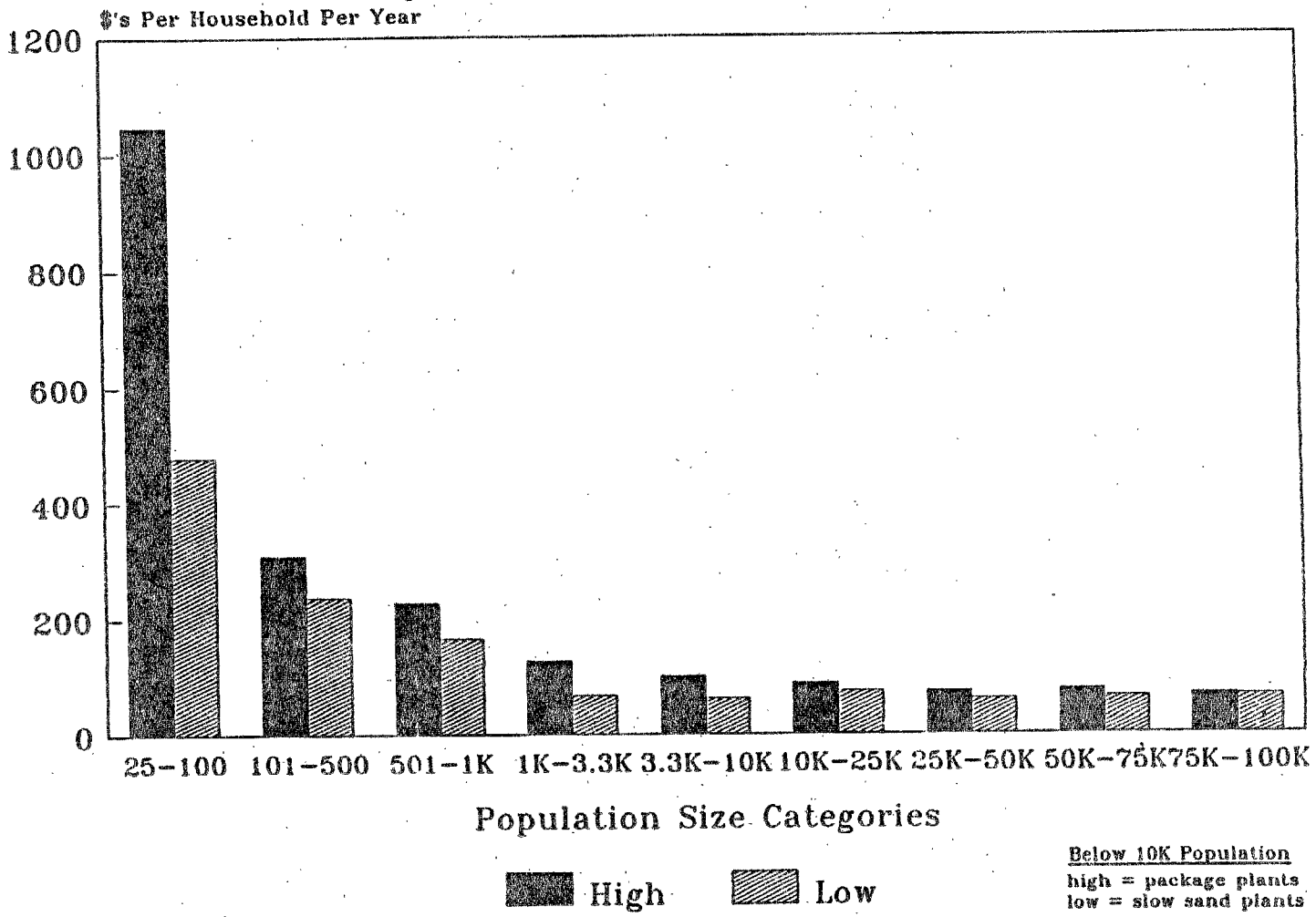
FIGURE VI-1

Cost of Installing Filtration in Systems Serving < 100,000



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D. Costs of Compliance for Currently Filtered Surface Water Systems

EPA estimated the total national cost of the turbidity performance requirements for filtered systems using a methodology which utilized survey data from a random sample of over 500 water systems, stratified by system size. The survey data provide a profile of the type of filtration technologies currently in place and their turbidity performance. A summary of the survey data is presented elsewhere (ASDWA, 1986).

EPA estimates that the average monthly turbidity in the water industry is currently 0.7 NTU. For the purposes of the Regulatory Impact Analysis, EPA assumed that the turbidity performance requirement in this final rule (less than 0.5 NTU, 95 percent of the time) for systems using rapid granular media filtration, i.e., direct filtration or conventional treatment (systems using diatomaceous earth or slow sand have less stringent turbidity performance requirements), is equivalent to a monthly average of about 0.3 NTU. From the survey data, EPA estimated that approximately 5,128 systems exceed this average. Of these, 1,409 are estimated to be in violation of the interim turbidity requirement, which is a monthly average of 1 NTU.

EPA further subdivided the systems which currently do not meet the turbidity performance requirements in the final rule by size and type of filtration process currently in place. A forecast of the likely compliance choices of systems in each subcategory was developed. The compliance choices evaluated include various combinations of the following:

- Hiring a consulting engineer to do a diagnostic analysis;
- Improving operation and maintenance practices;
- Adding rapid mix;
- Adding pH adjustment capability;
- Replacing filter media;
- Adding polymer;
- Adding alum or $FeCl_3$;
- Adding flocculation or contact chambers.

The system-level cost of each of the above compliance options is estimated elsewhere (USEPA, 1987c, 1988a). Average system-level costs based on various combinations of these options, are shown in Table VI–3. The total national capital cost, based on predicted compliance choices, is $403 million. The total annualized cost is $113 million.

TABLE VI–3.—COSTS OF UPGRADING TO MEET TURBIDITY PERFORMANCE REQUIREMENTS

System size (by population served)	Costs (¢/1,000 gallons)
25 to 100	78
101 to 500	32
501 to 1,000	27
1,001 to 3,300	15
3,301–10,000	7
10,001–25,000	3
25,001–50,000	2
>50,000	<2

These national cost estimates for compliance with the turbidity requirements may be on the high side because the turbidity performance profile which underlies the analysis is based on survey results which embody a certain amount of statistical error. The foremost concern is that the survey solicited data on monthly average turbidity. Under the interim turbidity requirement, it is conceivable that there are many water systems that are monitoring well enough to document they are below a 1 NTU monthly average, but not well enough to document lower levels with precision. Measurement in the 0.3 NTU range would require greater care. Thus, some of the systems believed to be above a monthly average of 0.3 NTU may require no more than better monitoring to demonstrate compliance.

On the basis of data developed in a survey conducted by the American Water Works Association (AWWA, 1987), EPA estimates that approximately 1,163 filtered surface water systems currently do not meet the disinfection performance requirements of this final rule and will have to undertake modifications to upgrade their disinfection practices.

To meet the inactivation levels specified in the final rule, systems are expected to choose from among several compliance options, including:

- Increasing the chlorine or ozone dose;
- Baffling clearwells;
- Relocating the point(s) of ammoniation/chlorination;
- Adding storage to increase disinfectant contact time;
- Applying ozone or chlorine dioxide as alternate disinfectants;
- Combinations of the above.

From this mix of compliance options, assumptions were made regarding the ones which will be selected by systems in different size categories, and the average cost of compliance estimated. The results are presented in Table VI–4.

TABLE VI–4.—COSTS OF UPGRADING TO MEET DISINFECTION PERFORMANCE REQUIREMENTS

System size (by population served)	Costs (¢/1,000 gallons)
25 to 100	61
101 to 500	22
501 to 1,000	10
1,001 to 3,300	6
3,301 to 10,000	4
10,001 to 25,000	3
25,001 to 50,000	2
50,001 to 100,000	2
>100,000	1

E. Benefits

In the November 3, 1987 proposal, EPA estimated there are between 212,000 and 470,000 cases of waterborne disease annually in the United States among persons served by surface water systems, as described below.

- First, EPA used data collected over a 15-year period by the Centers for Disease Control (CDC) on the number of reported outbreaks (106) and the number of cases of disease (34,436) to obtain an estimate of the average number of illnesses per outbreak (325).
- Second, to compensate for widespread underreporting in the number of outbreaks, the reported number above (106) was multiplied by a factor of four.
- Third, the adjusted number of outbreaks per year (424 divided by 15) was multiplied by the average number of cases per outbreak (325) to obtain an estimate of the number of cases of disease per year attributable to waterborne disease outbreaks. EPA considered this result (9,183 cases of illness) the "lower bound" estimate.
- Next, the "upper bound" estimate of cases of illness was calculated. To compensate for underreporting in the number of cases of illness in systems serving 100,000 or fewer people, it was assumed that half of the population exposed during an outbreak episode became ill. (This assumption replaced the estimate of 325 cases of illness per outbreak.) Using this approach, the number of cases of illness per year was estimated to be 50,740.
- In addition, for systems serving more than 100,000 people, it was assumed that there would be two outbreaks per year—one in a large filtered system, and one in a large unfiltered system. Assuming an average of 6,000 cases of illness per outbreak in large systems, based upon CDC data of recent record, EPA estimated that there would be 12,000 cases of illness per year

attributable to outbreaks in systems serving more than 100,000 people.

• Finally, the 50,740 and 12,000 cases, calculated above, were added together to obtain a total of 62,740 cases of illness, taking into account underreporting of the number of cases.

In addition to illnesses observed during an outbreak, there are waterborne illnesses occurring throughout the year, but not at sufficiently high rates to attract attention as an outbreak. These endemic illnesses were estimated using a different methodology, as follows:

• First, it was assumed that the rate of giardiasis in unfiltered systems was similar to that observed in townships adjacent to Luzerne County, Pennsylvania, (i.e., one percent) at the time a significant outbreak occurred in 1983. For populations served by unfiltered systems, it was assumed that the rate ranged from a maximum of one percent to a minimum of one-quarter of one percent. For filtered systems, it was assumed that the rates were half those of unfiltered systems.

• Next, EPA applied these rates to the population served by filtered and unfiltered systems to obtain an estimate of the upper and lower bounds of the number of endemic cases of illness per year (see Table VI–5).

TABLE VI–5.—BASELINE NUMBER OF ENDEMIC CASES PER YEAR AS ESTIMATED IN THE DRAFT REGULATORY IMPACT ANALYSIS (USEPA, 1987c)

Endemic analysis	Assumed endemic rate		Population exposed	Lower bound endemic cases/yr	Upper bound endemic cases/yr
	Lower bound	Upper bound			
Unfiltered systems:					
Large systems (>100,000)	0.0025	0.005	16,000,000	40,000	80,000
Small systems (<100,000)	0.005	0.01	5,649,353	28,247	56,494
Total, unfiltered			21,649,353	68,247	136,494
Filtered systems:					
Large systems (>100,000)	0.00125	0.0025	34,288,580	42,861	85,721
Small systems (<100,000)	0.0025	0.005	36,764,700	91,912	183,824
Total, filtered			71,053,280	134,773	269,545
Total, filtered and unfiltered			92,702,633	203,020	406,039

• Finally, the lower bound estimates of cases of illness from outbreaks (9,183) and endemic illnesses (203,020) were added together to obtain the lower end of the range of illnesses (212,203). Doing the same for the upper bound estimates (62,740 + 406,039) resulted in an estimate of 468,779 total cases of waterborne illness.

Based on information submitted by several commenters, new data on the occurrence of *Giardia*, and a revised methodology for the estimation of the number of endemic cases of illness, these estimates have been substantially revised. EPA now estimates that currently there are approximately 89,000 cases of waterborne disease annually in systems using surface water. This figure was derived as follows:

• Using data on occurrence of *Giardia* in source water from Rose (1988) and estimates of treatment efficiences, EPA estimated the present exposure to *Giardia* of people served by filtered and unfiltered systems in different size categories.

• Next, these data were applied to a dose-response model (Rose, 1988) to determine the daily individual risk of disease associated with the above exposure.

• The daily individual risk was then converted to an annual risk and applied to the population served to estimate the number of cases of endemic illness per year from giardiasis in the absence of the treatment requirements of this rule.

• Then, based on an analysis of the relative rates of all waterborne disease, this value was adjusted upwards by 85 percent to take into account diseases other than giardiasis.

• Finally, the number of cases of disease which will be avoided by compliance with the rule was estimated based on the increase in removal and/or inactivation of pathogenic microorganisms expected from implementation of today's requirements.

Using this methodology, EPA estimated that this final rule will prevent 79,854 endemic cases of disease per year. In addition, 9,294 outbreak cases will be avoided as a result of compliance with this rule. This number was estimated using the same methodology employed in the draft Regulatory Impact Analysis (USEPA, 1987c) but is slightly higher (9,294 versus 9,183 for the lower bound estimate) because of revisions to the data base since the rule was proposed.

The total number of cases avoided per year, 89,148, represents EPA's best point estimate, or best single value, of the benefits of the rule. The Agency also calculated an upper and lower bound, based on the 95 percent confidence interval around the dose-response curve. By this method, the number of endemic cases could be as high as 149,181, or as low as 36,980. Thus, the total cases avoided per year could range from 46,274 to 158,475. In addition, EPA believes that many more cases than the number given may be avoided by implementation of this rule because the number of cases per outbreak is understated (it was not adjusted, as was done for underreporting in the number of outbreaks). By one account, the underreporting in cases per outbreak could be on the order of twenty-five times the actual levels reported (Hauschild, A.F. and Bryan, F., 1980).

EPA also examined the net benefits of installing filtration at the individual water system level. Net benefits were analyzed for systems of various sizes by estimating the annual expected value of economic damages resulting from various levels of endemic and outbreak disease incidence in communities of various sizes and subtracting the annual cost of installing filtration.

It is important to note that it is difficult to estimate the value of the benefits associated with reducing the endemic and outbreak incidence of waterborne disease, because there are many benefits which cannot be quantified. As described at length previously (USEPA, 1987c), EPA's analysis is structured upon hypothetical

assumptions which have been developed on the basis of the insights gained in two documented case studies: A 1981 outbreak of viral gastroenteritis in Eagle-Vail, Colorado (Hopkins, 1986), and a 1983 outbreak of giardiasis in Luzerne County, Pennsylvania (Harrington, 1985). The damage functions derived from these studies consist primarily of two types of costs: (1) Direct costs of medical treatment and the value of lost work, and (2) costs incurred due to "averting behavior" such as boiling water or purchasing bottled water undertaken in the event of an outbreak. While it is difficult to generalize from the results of case studies, it is currently the best means of estimating damages.

Another shortcoming with the net benefits analysis at the time of proposal, and perhaps the biggest one, is the degree of uncertainty in the assumptions made regarding both the endemic and outbreak incidence of waterborne disease. It was estimated (Craun, 1987) that the annual probability of outbreak incidence in unfiltered surface water systems—averaging all such systems together—is roughly once in every one hundred years. Data with which to assess the endemic level of waterborne disease (the sub-outbreak, baseline level of disease) were not available at the time of the November 1987 proposal. Therefore, the net benefits analysis was conducted in a manner intended to show what assumptions regarding the endemic level of disease would have to hold true in order to produce net benefits near the margin (i.e., the point where net benefits approach zero), indicating that filtration is a breakeven or better proposition.

In the draft Regulatory Impact Analysis (USEPA, 1987c), an assumption of an endemic level of disease of 0.5 percent of the exposed population was required to produce marginally positive or marginally negative net benefits in the fifteen unfiltered systems serving more than 100,000 persons, assuming a one percent annual probability of an outbreak (once every 100 years). An endemic level assumption of 1.0 percent was required to produce marginally positive or marginally negative net benefits in systems serving between 1,000 and 100,000 persons. It was not possible to produce positive net benefit estimates near the margin for systems serving fewer than 1,000 persons. (Endemic level assumptions significantly above 1.0 percent were required; such levels would probably begin to become associated with epidemic, rather than endemic, incidence.)

The breakeven assumptions regarding the probability of outbreak and the endemic level of waterborne disease were the subject of extensive comments on the proposed rule.

Several large systems stated that the probability of outbreak, computed by averaging all unfiltered systems together, yields an estimate which overstates the risk of outbreak in large systems that have diligent watershed management and disinfection programs. It has been contended that such systems can reduce the risk of outbreak to a level comparable to that achieved by filtered systems (the reported outbreak risk in filtered systems is 1/750 years according to Craun, 1987). This perception of outbreak risk in large systems is consistent with the rationale for providing criteria to avoid filtration for such systems in the proposed rule. On the other hand, two systems among the fifteen unfiltered surface systems serving more than 100,000 persons have experienced outbreaks since 1982, suggesting there may be some large systems for which the probability of an outbreak is greater than 1/750.

Many commenters expressed the view that the endemic levels of waterborne disease assumed in the net benefits analysis (5×10^{-3} for systems >100,000; 1×10^{-2} for systems ≤100,000) are much higher than the levels actually occurring.

As explained earlier, since publication of the proposed rule, new information has become available which has made it possible to assess the validity of the endemic level assumptions using a toxicological, or dose/response, approach to estimation. The average concentration of *Giardia* cysts in water sources with "pristine," or protected, watersheds has been estimated to be 9×10^{-3} cysts per liter (Rose, 1988). An EPA study (USEPA, 1988a) of disinfection practices at unfiltered systems shows that systems are currently achieving an average of 1.34 logs of inactivation. Thus, the implied average dose to consumers is 4×10^{-4} cysts/liter. A recently developed dose/response function (Rose, 1988) indicates that this exposure results in a daily risk of 1.65×10^{-5} and is equivalent to an annual endemic rate of 3×10^{-3}. This estimated average endemic level is relatively close to the range of 5×10^{-3} to 1×10^{-2} originally assumed to be the endemic level in the net benefits analysis at the time of proposal, lending support to the validity of the assumption.

The above risk assessment indicates that unfiltered systems achieving average levels of inactivation may be facing greater risk of outbreak and incurring higher levels of endemic disease than may be evident from the number of cases reported. It should be noted however that, since this estimate is based on average influent levels and average inactivation rates, actual levels will vary. Systems achieving higher inactivation rates are probably correct in their assessment that they are not experiencing endemic levels on the order of 10^{-3} or 10^{-2}. On the other hand, by definition, there also is variation on the other side of the average estimate, indicating that there may be systems which are experiencing endemic levels higher than 3×10^{-3}. In addition, it must be kept in mind that *Giardia* is not the only pathogen that contributes to the overall endemic incidence of waterborne disease. Data reported to the Centers for Disease Control indicate there are 0.85 cases of other types of waterborne disease for every case of giardiasis. Thus, while it is true that some systems are not experiencing the levels of outbreak risk and endemic incidence that are associated with breakeven benefit/cost economics, it is also clear that there are other water systems which may fall within the range of the breakeven assumptions. Most importantly, there may be many water systems in which it is not possible to make a definitive assessment of the risk.

If the *Giardia* occurrence data presently available to EPA is representative of unfiltered systems, the treatment requirements will, by requiring a minimum of 3-log removal and/or inactivation of *Giardia*, reduce the maximum daily risk—the risk on days of peak occurrence—to 4.56×10^{-5}; the average daily risk to 3.6×10^{-7}; and the average annual endemic level to 6.57×10^{-5}. These levels provide virtually complete assurance against outbreaks caused by *Giardia* cysts, as well as most other pathogens, and assure negligible levels of endemic incidence. A significant additional benefit of the treatment requirements, therefore, is the confidence derived from knowing they factor in an adequate margin of safety.

As stated earlier, the estimated cost of this rule is approximately 50 percent greater than that estimated at the time of proposal. When combined with substantially fewer cases of illness avoided, the net benefits for systems in different size categories necessarily become less advantageous than previously estimated. But the way to best generalize about the effect on public water systems is not unequivocal. On the one hand, an analysis focusing on the typical system in each size category and using EPA's best estimate

of the benefits (Exhibit 5–10 of the Regulatory Impact Analysis) leads to the conclusion that household net benefits may be negative for currently unfiltered systems required to install filtration, possibly as much as $262 per household per year (in systems serving fewer than 100 people). However, this interpretation is not entirely valid because this result applies to the typical system in each of these size categories, not to all systems. Moreover, the benefit analysis did not include all business benefits; benefits accruing from the avoidance of pain and suffering; and benefits from reduced anxiety over the safety of the water. Since EPA's calculation is only a partial measure of benefits it is reasonable to conclude that actual net benefits in all size categories may be greater. In addition, small systems unable to meet the criteria to avoid filtration would probably investigate less expensive options than filtration, such as conversion to ground water or connection to a larger regional water system, which will increase the net benefits. Under SDWA, exemptions are also available. Under this provision, a system might use interim alternatives such as bottled water and point-of-use devices, with State approval, thereby incurring lower compliance costs (at least temporarily), and thus experience concomitant higher net benefits. In the case of systems which do not serve more than 500 service connections and which need financial assistance for the necessary improvements, the SDWA permits the exemption to be renewed for one or more additional two-year periods if the system establishes that it is taking all practical steps and there is no unreasonable risk to health, thereby further reducing cost impacts.

Another way of evaluating the benefits of these requirements is to consider the percent of the population experiencing positive and negative net benefits. This is presented in Table VI–6. For the estimate of outbreak probability most in keeping with available data (once in one hundred years), systems serving approximately 90 percent of the population will achieve positive net benefits, predominantly because currently filtered systems will incur small costs to comply with the rule. In most of the remaining systems, customers will generally pay only up to about $20 more than the value of the benefits quantified. Less than one percent of the affected population is expected to incur household net benefits of minus $40 or more, and these would only occur in systems serving fewer than 1,000 people. And these percentages would be even lower if all of the benefits had been captured in the analysis, and alternatives to filtration considered.

TABLE VI–6.—PERCENT OF AFFECTED POPULATION INCURRING VARYING LEVELS OF POSITIVE AND NEGATIVE NET HOUSEHOLD BENEFITS WHERE THE PROBABILITY OF AN OUTBREAK IS 1/100 YEARS

Net household benefits ($/HH/Yr)	Approximate percent of the affected population
Greater than 0	90
−20 to 0	8
−40 to −20	1
Less than −40	<1

VII. Other Requirements

A. Regulatory Flexibility Act

The Regulatory Flexibility Act, 5 U.S.C. 602 *et seq.*, requires EPA to explicitly consider the effect of proposed regulations on small entities. If there is a significant effect on a substantial number of small systems, the Agency must seek means to minimize the effects. EPA has concluded that this final rule will not have a significant effect on a substantial number of small entities, for purposes of the Regulatory Flexibility Act.

The Small Business Administration defines a "small water utility" as one which serves fewer than 50,000 people. There are about 199,000 public water systems using surface and ground water supplies which are considered small systems under this definition. Of those, about 11,000 systems are expected to incur total annualized costs of $333 to $439 million per year to comply with the rule. Compared to total operating expenses of $14.7 billion per year for this group, the cost of compliance amounts to an increase of 2.3 percent to 3.0 percent over current operating costs. EPA believes that an increase of this magnitude is not a substantial economic impact within the meaning of the Regulatory Flexibility Act. However, EPA recognizes that today's action could have a substantial effect on some small systems. Therefore, the Agency has attempted to provide less burdensome alternatives to achieve the rule's goals for small systems wherever possible. To illustrate:

- With respect to monitoring of the disinfectant residual at the entry point to the distribution system, systems serving fewer than 3,300 people may take grab samples in lieu of using continuous-monitoring equipment;
- With respect to disinfectant residuals in the distribution system, systems which are unable to maintain such residuals will still be considered in compliance if the State determines that it is not feasible for that system to monitor for HPC, and that disinfection is adequate, based on a review of site-specific considerations (e.g., source water quality, past coliform monitoring results);
- With respect to the turbidity monitoring, for filtered systems serving fewer than 500 people, the State may reduce the number of samples to one per day if it finds that the historical performance and operation of the system indicates effective particle removal under the conditions expected to occur in that system.

In addition, many of the provisions of this rule allow the State to modify the stated requirements in appropriate cases, regardless of system size. Although not specifically aimed at reducing the burden on small systems, these systems may avail themselves of such flexibility in the same manner as their larger counterparts.

B. Paperwork Reduction Act

The information collection requirements contained in this rule have been submitted to the Office of Management and Budget (OMB) under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* The information collection requirements are not effective until OMB approves them and a technical amendment to that effect is published in the Federal Register.

The public reporting burden on public water systems for this collection of information is estimated to average 0.1 hours per response (i.e., sample taken, or report submitted to the State or EPA), including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch, PM-223, U.S. Environmental Protection Agency, 401 M St., SW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA."

C. National Drinking Water Advisory Council and Science Advisory Board

In accordance with section 1412 (d) and (e) of the Safe Drinking Water Act, EPA consulted with the Secretary and the National Drinking Water Advisory Council and requested comments from the Science Advisory Board in the course of developing these MCLGs and NPDWRs.

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List of Subjects in 40 CFR Parts 141 and 142

Chemicals, Incorporation by reference, Intergovernmental relations, Reporting and recordkeeping requirements, Water supply, Administrative practice and procedure.

Dated: June 19, 1989.

William K. Reilly,

Administrator.

For the reasons set forth in the preamble, Title 40 of the Code of Federal Regulations is amended as follows:

PART 141—NATIONAL PRIMARY DRINKING WATER REGULATIONS

1. The authority for Part 141 is revised to read as follows:

Authority: 42 U.S.C. 300f, 300g–1, 300g–2, 300g–3, 300g–4, 300g–5, 300g–6, 300j–4, and 300j–9.

2. In § 141.2, the following definitions are added and arranged alphabetically to read as follows:

§ 141.2 Definitions.

* * * * *

"Coagulation" means a process using coagulant chemicals and mixing by which colloidal and suspended materials are destabilized and agglomerated into flocs.

"Conventional filtration treatment" means a series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal.

* * * * *

"CT" or "CTcalc" is the product of "residual disinfectant concentration" (C) in mg/l determined before or at the first customer, and the corresponding "disinfectant contact time" (T) in minutes, i.e., "C" x "T". If a public water system applies disinfectants at more than one point prior to the first customer, it must determine the CT of each disinfectant sequence before or at the first customer to determine the total percent inactivation or "total inactivation ratio." In determining the total inactivation ratio, the public water system must determine the residual disinfectant concentration of each disinfection sequence and corresponding contact time before any subsequent disinfection application point(s). "$CT_{99.9}$" is the CT value required for 99.9 percent (3–log) inactivation of *Giardia lamblia* cysts. $CT_{99.9}$ for a variety of disinfectants and conditions appear in Tables 1.1–1.6, 2.1, and 3.1 of § 141.74(b)(3).

$$\frac{CTcalc}{CT_{99.9}}$$

is the inactivation ratio. The sum of the inactivation ratios, or total inactivation ratio shown as

$$\sum \frac{(CTcalc)}{(CT_{99.9})}$$

is calculated by adding together the inactivation ratio for each disinfection sequence. A total inactivation ratio equal to or greater than 1.0 is assumed to provide a 3-log inactivation of *Giardia lamblia* cysts.

"Diatomaceous earth filtration" means a process resulting in substantial particulate removal in which (1) a precoat cake of diatomaceous earth filter media is deposited on a support membrance (septum), and (2) while the water is filtered by passing through the cake on the septum, additional filter media known as body feed is continuously added to the feed water to maintain the permeability of the filter cake.

"Direct filtration" means a series of processes including coagulation and filtration but excluding sedimentation resulting in substantial particulate removal.

* * * * *

"Disinfectant contact time" ("T" in CT calculations) means the time in minutes that it takes for water to move from the point of disinfectant application or the previous point of disinfectant residual measurement to a point before or at the point where residual disinfectant concentration ("C") is measured. Where only one "C" is measured, "T" is the time in minutes that it takes for water to move from the point of disinfectant application to a point before or at where residual disinfectant concentration ("C") is measured. Where more than one "C" is measured, "T" is (a) for the first measurement of "C", the time in minutes that it takes for water to move from the first or only point of disinfectant application to a point before or at the point where the first "C" is measured and (b) for subsequent measurements of "C", the time in minutes that it takes for water to move from the previous "C" measurement point to the "C" measurement point for which the particular "T" is being calculated. Disinfectant contact time in pipelines must be calculated based on "plug flow" by dividing the internal volume of the pipe by the maximum hourly flow rate through that pipe. Disinfectant contact time within mixing basins and storage reservoirs must be determined by tracer studies or an equivalent demonstration.

"Disinfection" means a process which inactivates pathogenic organisms in water by chemical oxidants or equivalent agents.

* * * * *

"Filtration" means a process for removing particulate matter from water by passage through porous media.

"Flocculation" means a process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable particles through gentle stirring by hydraulic or mechanical means.

"Ground water under the direct influence of surface water" means any water beneath the surface of the ground with (1) significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*, or (2) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources in accordance with criteria established by the State. The State determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation.

* * * * *

"*Legionella*" means a genus of bacteria, some species of which have caused a type of pneumonia called Legionnaires Disease.

"Point of disinfectant application" is the point where the disinfectant is applied and water downstream of that point is not subject to recontamination by surface water runoff.

"Residual disinfectant concentration" ("C" in CT calculations) means the concentration of disinfectant measured in mg/l in a representative sample of water.

* * * * *

"Sedimentation" means a process for removal of solids before filtration by gravity or separation.

"Slow sand filtration" means a process involving passage of raw water

through a bed of sand at low velocity (generally less than 0.4 m/h) resulting in substantial particulate removal by physical and biological mechanisms.

* * * * *

"Surface water" means all water which is open to the atmosphere and subject to surface runoff.

* * * * *

"Waterborne disease outbreak" means the significant occurrence of acute infectious illness, epidemiologically associated with the ingestion of water from a public water system which is deficient in treatment, as determined by the appropriate local or State agency.

"Virus" means a virus of fecal origin which is infectious to humans by waterborne transmission.

3. Section 141.13 is amended by adding introductory text to read as follows:

§ 141.13 Maximum contaminant levels for turbidity.

The requirements in this section apply to unfiltered systems until December 30, 1991, unless the State has determined prior to that date, in writing pursuant to § 1412(b)(7)(C)(iii), that filtration is required. The requirements in this section apply to filtered systems until June 29, 1993. The requirements in this section apply to unfiltered systems that the State has determined, in writing pursuant to § 1412(b)(7)(C)(iii), must install filtration, until June 29, 1993, or until filtration is installed, whichever is later.

* * * * *

4. Section 141.22 is amended by adding introductory text to read as follows:

§ 141.22 Turbidity sampling and analytical requirements.

The requirements in this section apply to unfiltered systems until December 30,1991, unless the State has determined prior to that date, in writing pursuant to section 1412(b)(7)(iii), that filtration is required. The requirements in this section apply to filtered systems until June 29, 1993. The requirements in this section apply to unfiltered systems that the State has determined, in writing pursuant to section 1412(b)(7)(C)(iii), must install filtration, until June 29, 1993, or until filtration is installed, whichever is later.

* * * * *

5. Section 141.32 is amended by adding new paragraphs (a)(1)(iii)(D) and (e)(10) to read as follows:

§ 141.32 Public notification.

* * * * *

(a) * * *

(1) * * *

(iii) * * *

(D) Occurrence of a waterborne disease outbreak, as defined in § 141.2, in an unfiltered system subject to the requirements of Subpart H of this part, after December 30, 1991 (see § 141.71(b)(4)).

* * * * *

(e) * * *

(10) *Microbiological contaminants* (for use when there is a violation of the treatment technique requirements for filtration and disinfection in Subpart H of this part). The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that the presence of microbiological contaminants are a health concern at certain levels of exposure. If water is inadequately treated, microbiological contaminants in that water may cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and any associated headaches and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA has set enforceable requirements for treating drinking water to reduce the risk of these adverse health effects. Treatment such as filtering and disinfecting the water removes or destroys microbiological contaminants. Drinking water which is treated to meet EPA requirements is associated with little to none of this risk and should be considered safe.

6. In Part 141, a new § 141.52 is added to read as follows:

§ 141.52 Maximum contaminant level goals for microbiological contaminants.

MCLGs for the following contaminants are as indicated:

Contaminant	MCLG
(1) *Giardia lamblia*	zero
(2) Viruses	zero
(3) *Legionella*	zero

7. A new Subpart H is added to read as follows:

Subpart H—Filtration and Disinfection

Sec.

Subpart H—Filtration and Disinfection

§ 141.70 General requirements.

(a) The requirements of this Subpart H constitute national primary drinking water regulations. These regulations establish criteria under which filtration is required as a treatment technique for public water systems supplied by a surface water source and public water systems supplied by a ground water source under the direct influence of surface water. In addition, these regulations establish treatment technique requirements in lieu of maximum contaminant levels for the following contaminants: *Giardia lamblia*, viruses, heterotrophic plate count bacteria, *Legionella*, and turbidity. Each public water system with a surface water source or a ground water source under the direct influence of surface water must provide treatment of that source water that complies with these treatment technique requirements. The treatment technique requirements consist of installing and properly operating water treatment processes which reliably achieve:

(1) At least 99.9 percent (3-log) removal and/or inactivation of *Giardia lamblia* cysts between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer; and

(2) At least 99.99 percent (4-log) removal and/or inactivation of viruses between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer.

(b) A public water system using a surface water source or a ground water source under the direct influence of surface water is considered to be in compliance with the requirements of paragraph (a) of this section if:

(1) It meets the requirements for avoiding filtration in § 141.71 and the disinfection requirements in § 141.72(a); or

(2) It meets the filtration requirements in § 141.73 and the disinfection requirements in § 141.72(b).

(c) Each public water system using a surface water source or a ground water source under the direct influence of surface water must be operated by qualified personnel who meet the requirements specified by the State.

§ 141.71 Criteria for avoiding filtration.

A public water system that uses a surface water source must meet all of the conditions of paragraphs (a) and (b) of this section, and is subject to

paragraph (c) of this section, beginning December 30, 1991, unless the State has determined, in writing pursuant to § 1412(b)(7)(C)(iii), that filtration is required. A public water system that uses a ground water source under the direct influence of surface water must meet all of the conditions of paragraphs (a) and (b) of this section and is subject to paragraph (c) of this section, beginning 18 months after the State determines that it is under the direct influence of surface water, or December 30, 1991, whichever is later, unless the State has determined, in writing pursuant to § 1412(b)(7)(C)(iii), that filtration is required. If the State determines in writing pursuant to § 1412(b)(7)(C)(iii) before December 30, 1991, that filtration is required, the system must have installed filtration and meet the criteria for filtered systems specified in §§ 141.72(b) and 141.73 by June 29, 1993. Within 18 months of the failure of a system using surface water or a ground water source under the direct influence of surface water to meet any one of the requirements of paragraphs (a) and (b) of this section or after June 29, 1993, whichever is later, the system must have installed filtration and meet the criteria for filtered systems specified in §§ 141.72(b) and 141.73.

(a) *Source water quality conditions.* (1) The fecal coliform concentration must be equal to or less than 20/100 ml, or the total coliform concentration must be equal to or less than 100/100 ml (measured as specified in § 141.74 (a)(1) and (2) and (b)(1)), in representative samples of the source water immediately prior to the first or only point of disinfectant application in at least 90 percent of the measurements made for the 6 previous months that the system served water to the public on an ongoing basis. If a system measures both fecal and total coliforms, the fecal coliform criterion, but not the total coliform criterion, in this paragraph must be met.

(2) The turbidity level cannot exceed 5 NTU (measured as specified in § 141.74 (a)(4) and (b)(2)) in representative samples of the source water immediately prior to the first or only point of disinfectant application unless: (i) the State determines that any such event was caused by circumstances that were unusual and unpredictable; and (ii) as a result of any such event, there have not been more than two events in the past 12 months the system served water to the public, or more than five events in the past 120 months the system served water to the public, in which the turbidity level exceeded 5 NTU. An "event" is a series of consecutive days during which at least one turbidity measurement each day exceeds 5 NTU.

(b) *Site-specific conditions.* (1)(i) The public water system must meet the requirements of § 141.72(a)(1) at least 11 of the 12 previous months that the system served water to the public, on an ongoing basis, unless the system fails to meet the requirements during 2 of the 12 previous months that the system served water to the public, and the State determines that at least one of these failures was caused by circumstances that were unusual and unpredictable.

(ii) The public water system must meet the requirements of § 141.72(a)(2) at all times the system serves water to the public.

(iii) The public water system must meet the requirements of § 141.72(a)(3) at all times the system serves water to the public unless the State determines that any such failure was caused by circumstances that were unusual and unpredictable.

(iv) The public water system must meet the requirements of § 141.72(a)(4) on an ongoing basis unless the State determines that failure to meet these requirements was not caused by a deficiency in treatment of the source water.

(2) The public water system must maintain a watershed control program which minimizes the potential for contamination by *Giardia lamblia* cysts and viruses in the source water. The State must determine whether the watershed control program is adequate to meet this goal. The adequacy of a program to limit potential contamination by *Giardia lamblia* cysts and viruses must be based on: the comprehensiveness of the watershed review; the effectiveness of the system's program to monitor and control detrimental activities occurring in the watershed; and the extent to which the water system has maximized land ownership and/or controlled land use within the watershed. At a minimum, the watershed control program must:

(i) Characterize the watershed hydrology and land ownership;

(ii) Identify watershed characteristics and activities which may have an adverse effect on source water quality; and

(iii) Monitor the occurrence of activities which may have an adverse effect on source water quality.

The public water system must demonstrate through ownership and/or written agreements with landowners within the watershed that it can control all human activities which may have an adverse impact on the microbiological quality of the source water. The public water system must submit an annual report to the State that identifies any special concerns about the watershed and how they are being handled; describes activities in the watershed that affect water quality; and projects what adverse activities are expected to occur in the future and describes how the public water system expects to address them. For systems using a ground water source under the direct influence of surface water, an approved wellhead protection program developed under section 1428 of the Safe Drinking Water Act may be used, if the State deems it appropriate, to meet these requirements.

(3) The public water system must be subject to an annual on-site inspection to assess the watershed control program and disinfection treatment process. Either the State or a party approved by the State must conduct the on-site inspection. The inspection must be conducted by competent individuals such as sanitary and civil engineers, sanitarians, or technicians who have experience and knowledge about the operation and maintenance of a public water system, and who have a sound understanding of public health principles and waterborne diseases. A report of the on-site inspection summarizing all findings must be prepared every year. The on-site inspection must indicate to the State's satisfaction that the watershed control program and disinfection treatment process are adequately designed and maintained. The on-site inspection must include:

(i) A review of the effectiveness of the watershed control program;

(ii) A review of the physical condition of the source intake and how well it is protected;

(iii) A review of the system's equipment maintenance program to ensure there is low probability for failure of the disinfection process;

(iv) An inspection of the disinfection equipment for physical deterioration;

(v) A review of operating procedures;

(vi) A review of data records to ensure that all required tests are being conducted and recorded and disinfection is effectively practiced; and

(vii) Identification of any improvements which are needed in the equipment, system maintenance and operation, or data collection.

(4) The public water system must not have been identified as a source of a waterborne disease outbreak, or if it has been so identified, the system must have been modified sufficiently to prevent another such occurrence, as determined by the State.

(5) The public water system must comply with the maximum contaminant level (MCL) for total coliforms in § 141.63 at least 11 months of the 12 previous months that the system served water to the public, on an ongoing basis, unless the State determines that failure to meet this requirement was not caused by a deficiency in treatment of the source water.

(6) The public water system must comply with the requirements for trihalomethanes in §§ 141.12 and 141.30.

(c) *Treatment technique violations.* (1) A system that (i) fails to meet any one of the criteria in paragraphs (a) and (b) of this section and/or which the State has determined that filtration is required, in writing pursuant to § 1412(b)(7)(C)(iii), and (ii) fails to install filtration by the date specified in the introductory paragraph of this section is in violation of a treatment technique requirement.

(2) A system that has not installed filtration is in violation of a treatment technique requirement if:

(i) The turbidity level (measured as specified in § 141.74(a)(4) and (b)(2)) in a representative sample of the source water immediately prior to the first or only point of disinfection application exceeds 5 NTU; or

(ii) The system is identified as a source of a waterborne disease outbreak.

§ 141.72 Disinfection.

A public water system that uses a surface water source and does not provide filtration treatment must provide the disinfection treatment specified in paragraph (a) of this section beginning December 30, 1991, unless the State determines that filtration is required in writing pursuant to § 1412 (b)(7)(C)(iii). A public water system that uses a ground water source under the direct influence of surface water and does not provide filtration treatment must provide disinfection treatment specified in paragraph (a) of this section beginning December 30, 1991, or 18 months after the State determines that the ground water source is under the influence of surface water, whichever is later, unless the State has determined that filtration is required in writing pursuant to § 1412(b)(7)(C)(iii). If the State has determined that filtration is required the system must comply with any interim disinfection requirements the State deems necessary before filtration is installed. A system that uses a surface water source that provides filtration treatment must provide the disinfection treatment specified in paragraph (b) of this section beginnng June 29, 1993, or beginning when filtration is installed, whichever is later. A system that uses a ground water source under the direct influence of surface water and provides filtration treatment must provide disinfection treatment as specified in paragraph (b) of this section by June 29, 1993, or beginning when filtration is installed, whichever is later. Failure to meet any requirement of this section after the applicable date specified in this introductory paragraph is a treatment technique violation.

(a) *Disinfection requirements for public water systems that do not provide filtration.* Each public water system that does not provide filtration treatment must provide disinfection treatment as follows:

(1) The disinfection treatment must be sufficient to ensure at least 99.9 percent (3-log) inactivation of *Giardia lamblia* cysts and 99.99 percent (4-log) inactivation of viruses, every day the system serves water to the public, except any one day each month. Each day a system serves water to the public, the public water system must calculate the CT value(s) from the system's treatment parameters, using the procedure specified in § 141.74(b)(3), and determine whether this value(s) is sufficient to achieve the specified inactivation rates for *Giardia lamblia* cysts and viruses. If a system uses a disinfectant other than chlorine, the system may demonstrate to the State, through the use of a State-approved protocol for on-site disinfection challenge studies or other information satisfactory to the State, that $CT_{99.9}$ values other than those specified in Tables 2.1 and 3.1 in § 141.74(b)(3) or other operational parameters are adequate to demonstrate that the system is achieving minimum inactivation rates required by paragraph (a)(1) of this section.

(2) The disinfection system must have either (i) redundant components, including an auxiliary power supply with automatic start-up and alarm to ensure that disinfectant application is maintained continuously while water is being delivered to the distribution system, or (ii) automatic shut-off of delivery of water to the distribution system whenever there is less than 0.2 mg/l of residual disinfectant concentration in the water. If the State determines that automatic shut-off would cause unreasonable risk to health or interfere with fire protection, the system must comply with paragraph (a)(2)(i) of this section.

(3) The residual disinfectant concentration in the water entering the distribution system, measured as specified in § 141.74(a)(5) and (b)(5), cannot be less than 0.2 mg/l for more than 4 hours.

(4)(i) The residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine, or chlorine dioxide, as specified in § 141.74(a)(5) and (b)(6), cannot be undetectable in more than 5 percent of the samples each month, for any two consecutive months that the system serves water to the public. Water in the distribution system with a heterotrophic bacteria concentration less than or equal to 500/ml, measured as heterotrophic plate count (HPC) as specified in § 141.74(a)(3), is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement. Thus, the value "V" in the following formula cannot exceed 5 percent in one month, for any two consecutive months.

$$V = \frac{c+d+e}{a+b} \times 100$$

where:

a = number of instances where the residual disinfectant concentration is measured;

b = number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;

c = number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;

d = number of instances where the residual disinfectant concentration is measured but not detected and where the HPC is >500/ml; and

e = number of instances where the residual disinfectant concentration is not measured and HPC is >500/ml.

(ii) If the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by § 141.74(a)(3) and that the system is providing adequate disinfection in the distribution system, the requirements of paragraph (a)(4)(i) of this section do not apply to that system.

(b) *Disinfection requirements for public water systems which provide filtration.* Each public water system that provides filtration treatment must provide disinfection treatment as follows.

(1) The disinfection treatment must be sufficient to ensure that the total treatment processes of that system achieve at least 99.9 percent (3-log) inactivation and/or removal of *Giardia lamblia* cysts and at least 99.99 percent

(4-log) inactivation and/or removal of viruses, as determined by the State.

(2) The residual disinfectant concentration in the water entering the distribution system, measured as specified in § 141.74 (a)(5) and (c)(2), cannot be less than 0.2 mg/l for more than 4 hours.

(3)(i) The residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine, or chlorine dioxide, as specified in § 141.74 (a)(5) and (c)(3), cannot be undetectable in more than 5 percent of the samples each month, for any two consecutive months that the system serves water to the public. Water in the distribution system with a heterotrophic bacteria concentration less than or equal to 500/ml, measured as heterotrophic plate count (HPC) as specified in § 141.74(a)(3), is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement. Thus, the value "V" in the following formula cannot exceed 5 percent in one month, for any two consecutive months.

$$V = \frac{c+d+e}{a+b} \times 100$$

where:

a = number of instances where the residual disinfectant concentration is measured;

b = number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;

c = number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;

d = number of instances where no residual disinfectant concentration is detected and where the HPC is >500/ml; and

e = number of instances where the residual disinfectant concentration is not measured and HPC is >500/ml.

(ii) If the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified in § 141.74(a)(3) and that the system is providing adequate disinfection in the distribution system, the requirements of paragraph (b)(3)(i) of this section do not apply.

§ 141.73 Filtration.

A public water system that uses a surface water source or a ground water source under the direct influence of surface water, and does not meet all of the criteria in § 141.71 (a) and (b) for avoiding filtration, must provide treatment consisting of both disinfection, as specified in § 141.72(b), and filtration treatment which complies with the requirements of paragraph (a), (b), (c), (d), or (e) of this section by June 29, 1993, or within 18 months of the failure to meet any one of the criteria for avoiding filtration in § 141.71 (a) and (b), whichever is later. Failure to meet any requirement of this section after the date specified in this introductory paragraph is a treatment technique violation.

(a) *Conventional filtration treatment or direct filtration.* (1) For systems using conventional filtration or direct filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 0.5 NTU in at least 95 percent of the measurements taken each month, measured as specified in § 141.74 (a)(4) and (c)(1), except that if the State determines that the system is capable of achieving at least 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts at some turbidity level higher than 0.5 NTU in at least 95 percent of the measurements taken each month, the State may substitute this higher turbidity limit for that system. However, in no case may the State approve a turbidity limit that allows more than 1 NTU in more than 5 percent of the samples taken each month, measured as specified in § 141.74 (a)(4) and (c)(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in § 141.74 (a)(4) and (c)(1).

(b) *Slow sand filtration.* (1) For systems using slow sand filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month, measured as specified in § 141.74 (a)(4) and (c)(1), except that if the State determines there is no significant interference with disinfection at a higher turbidity level, the State may substitute this higher turbidity limit for that system.

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in § 141.74 (a)(4) and (c)(1).

(c) *Diatomaceous earth filtration.* (1) For systems using diatomaceous earth filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month, measured as specified in § 141.74 (a)(4) and (c)(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in § 141.74 (a)(4) and (c)(1).

(d) *Other filtration technologies.* A public water system may use a filtration technology not listed in paragraphs (a)–(c) of this section if it demonstrates to the State, using pilot plant studies or other means, that the alternative filtration technology, in combination with disinfection treatment that meets the requirements of § 141.72(b), consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses. For a system that makes this demonstration, the requirements of paragraph (b) of this section apply.

§ 141.74 Analytical and monitoring requirements.

(a) *Analytical requirements.* Only the analytical method(s) specified in this paragraph, or otherwise approved by EPA, may be used to demonstrate compliance with the requirements of §§ 141.71, 141.72, and 141.73. Measurements for pH, temperature, turbidity, and residual disinfectant concentrations must be conducted by a party approved by the State. Measurements for total coliforms, fecal coliforms, and HPC must be conducted by a laboratory certified by the State or EPA to do such analysis. Until laboratory certification criteria are developed for the analysis of HPC and fecal coliforms, any laboratory certified for total coliform analysis by EPA is deemed certified for HPC and fecal coliform analysis. The following procedures shall be performed in accordance with the publications listed in the following section. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR Part 51. Copies of the methods published in *Standard Methods for the Examination of Water and Wastewater* may be obtained from the American Public Health Association et al., 1015 Fifteenth Street, NW., Washington, DC 20005; copies of the Minimal Medium ONPG–MUG Method as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and *Escherichia coli* from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.), Applied and Environmental Microbiology, Volume 54, pp. 1595–1601, June 1988 (as amended under Erratum, Applied and Environmental Microbiology, Volume 54, p. 3197, December, 1988), may be obtained from

the American Water Works Association Research Foundation, 6666 West Quincy Avenue, Denver, Colorado, 80235; and copies of the Indigo Method as set forth in the article "Determination of Ozone in Water by the Indigo Method" (Bader and Hoigne), may be obtained from Ozone Science & Engineering, Pergamon Press Ltd., Fairview Park, Elmsford, New York 10523. Copies may be inspected at the U.S. Environmental Protection Agency, Room EB15, 401 M Street, SW., Washington, DC 20460 or at the Office of the Federal Register, 1100 L Street, NW., Room 8401, Washington, DC.

(1) Fecal coliform concentration—Method 908C (Fecal Coliform MPN Procedures), pp. 878–880, Method 908D (Estimation of Bacterial Density), pp. 880–882, or Method 909C (Fecal Coliform Membrane Filter Procedure), pp. 896–898, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition.

(2) Total coliform concentration—Method 908A (Standard Total Coliform Multiple—Tube (MPN) Tests), pp. 872–876, Method 908B (Application of Tests to Routine Examinations), pp. 876–878, Method 908D (Estimation of Bacterial Density), pp. 880–882, Method 909A (Standard Total Coliform Membrane Filter Procedure), pp. 887–894, or Method 909B (Delayed—Incubation Total Coliform Procedure), pp. 894–896, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition; Minimal Medium ONPG–MUG Test, as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and *Escherichia coli* from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.), Applied and Environmental Microbiology, Volume 54, pp. 1595–1601, June 1988 (as amended under Erratum, Volume 54, p. 3197, December, 1988).

(Note: The Minimal Medium ONPG–MUG Test is sometimes referred to as the Autoanalysis Colilert System). Systems may use a five-tube test or a ten-tube test.

(3) Heterotrophic Plate Count—Method 907A (Pour Plate Method), pp. 864–866, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition.

(4) Turbidity—Method 214A (Nephelometric Method—Nephelometric Turbidity Units), pp. 134–136, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition.

(5) Residual disinfectant concentration—Residual disinfectant concentrations for free chlorine and combined chlorine (chloramines) must be measured by Method 408C (Amperometric Titration Method), pp. 303–306, Method 408D (DPD Ferrous Titrimetric Method), pp. 306–309, Method 408E (DPD Colorimetric Method), pp. 309–310, or Method 408F (Leuco Crystal Violet Method), pp. 310–313, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition. Residual disinfectant concentrations for free chlorine and combined chlorine may also be measured by using DPD colorimetric test kits if approved by the State. 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 on a regular basis, if approved by the State.

Note: This method will be published in the 17th edition of *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association et al.; the Iodometric Method in the 16th edition may not be used.

Residual disinfectant concentrations for chlorine dioxide must be measured by Method 410B (Amperometric Method) or Method 410C (DPD Method), pp. 322–324, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition.

(6) Temperature—Method 212 (Temperature), pp. 126–127, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition.

(7) pH—Method 423 (pH Value), pp. 429–437, as set forth in *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association, 16th edition.

(b) *Monitoring requirements for systems that do not provide filtration.* A public water system that uses a surface water source and does not provide filtration treatment must begin monitoring, as specified in this paragraph (b), beginning December 31, 1990, unless the State has determined that filtration is required in writing pursuant to § 1412(b)(7)(C)(iii), in which case the State may specify alternative monitoring requirements, as appropriate, until filtration is in place. A public water system that uses a ground water source under the direct influence of surface water and does not provide filtration treatment must begin monitoring as specified in this paragraph (b) beginning December 31, 1990, or 6 months after the State determines that the ground water source is under the direct influence of surface water, whichever is later, unless the State has determined that filtration is required in writing pursuant to § 1412(b)(7)(C)(iii), in which case the State may specify alternative monitoring requirements, as appropriate, until filtration is in place.

(1) Fecal coliform or total coliform density measurements as required by § 141.71(a)(1) must be performed on representative source water samples immediately prior to the first or only point of disinfectant application. The system must sample for fecal or total coliforms at the following minimum frequency each week the system serves water to the public:

System size (persons served)	Samples/week[1]
≤500	1
501 to 3,300	2
3,301 to 10,000	3
10,001 to 25,000	4
>25,000	5

[1] Must be taken on separate days.

Also, one fecal or total coliform density measurement must be made every day the system serves water to the public and the turbidity of the source water exceeds 1 NTU (these samples count towards the weekly coliform sampling requirement) unless the State determines that the system, for logistical reasons outside the system's control, cannot have the sample analyzed within 30 hours of collection.

(2) Turbidity measurements as required by § 141.71(a)(2) must be performed on representative grab samples of source water immediately prior to the first or only point of disinfectant application every four hours (or more frequently) that the system serves water to the public. A public water system may substitute continuous turbidity monitoring for grab sample monitoring if it validates the continuous measurement for accuracy on a regular basis using a protocol approved by the State.

(3) The total inactivation ratio for each day that the system is in operation

must be determined based on the $CT_{99.9}$ values in Tables 1.1–1.6, 2.1, and 3.1 of this section, as appropriate. The parameters necessary to determine the total inactivation ratio must be monitored as follows:

(i) The temperature of the disinfected water must be measured at least once per day at each residual disinfectant concentration sampling point.

(ii) If the system uses chlorine, the pH of the disinfected water must be measured at least once per day at each chlorine residual disinfectant concentration sampling point.

(iii) The disinfectant contact time(s) ("T") must be determined for each day during peak hourly flow.

(iv) The residual disinfectant concentration(s) ("C") of the water before or at the first customer must be measured each day during peak hourly flow.

(v) If a system uses a disinfectant other than chlorine, the system may demonstrate to the State, through the use of a State-approved protocol for on-site disinfection challenge studies or other information satisfactory to the State, that $CT_{99.9}$ values other than those specified in Tables 2.1 and 3.1 in this section other operational parameters are adequate to demonstrate that the system is achieving the minimum inactivation rates required by § 141.72(a)(1).

TABLE 1.1—CT VALUES ($CT_{99.9}$) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 0.5 °C OR LOWER [1]

Residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
<0.4	137	163	195	237	277	329	390
0.6	141	168	200	239	286	342	407
0.8	145	172	205	246	295	354	422
1.0	148	176	210	253	304	365	437
1.2	152	180	215	259	313	376	451
1.4	155	184	221	266	321	387	464
1.6	157	189	226	273	329	397	477
1.8	162	193	231	279	338	407	489
2.0	165	197	236	286	346	417	500
2.2	169	201	242	297	353	426	511
2.4	172	205	247	298	361	435	522
2.6	175	209	252	304	368	444	533
2.8	178	213	257	310	375	452	543
3.0	181	217	261	316	382	460	552

[1] These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature and at the higher pH.

TABLE 1.2— CT VALUES ($CT_{99.9}$) for 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 5.0 °C[1]

Free residual (mg/l)	pH						
	≦6.0	6.5	7.0	7.5	8.0	8.5	≦9.0
≦0.4	97	117	139	166	198	236	279
0.6	100	120	143	171	204	244	291
0.8	103	122	146	175	210	252	301
1.0	105	125	149	179	216	260	312
1.2	107	127	152	183	221	267	320
1.4	109	130	155	187	227	274	329
1.6	111	132	158	192	232	281	337
1.8	114	135	162	196	238	287	345
2.0	116	138	165	200	243	294	353
2.2	118	140	169	204	248	300	361
2.4	120	143	172	209	253	306	368
2.6	122	146	175	213	258	312	375
2.8	124	148	178	217	263	318	382
3.0	126	151	182	221	268	324	389

[1] These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature, and at the higher pH.

TABLE 1.3— CT VALUES ($CT_{99.9}$) for 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 10.0 °C[1]

Free residual (mg/l)	pH						
	≦6.0	6.5	7.0	7.5	8.0	8.5	≦9.0
≦0.4	73	88	104	125	149	177	209
0.6	75	90	107	126	153	183	218
0.8	78	92	110	131	158	189	226
1.0	79	94	112	134	162	195	234
1.2	80	95	114	137	166	200	240
1.4	82	98	116	140	170	206	247
1.6	83	99	119	144	174	211	253
1.8	86	101	122	147	179	215	259

TABLE 1.3— CT VALUES ($CT_{99.9}$) for 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 10.0 °C[1]— Continued

Free residual (mg/l)	pH						
	≦6.0	6.5	7.0	7.5	8.0	8.5	≦9.0
2.0	87	104	124	150	182	221	265
2.2	89	105	127	153	186	225	271
2.4	90	107	129	157	190	230	276
2.6	92	110	131	160	194	234	281
2.8	93	111	134	163	197	239	287
3.0	95	113	137	166	201	243	292

[1] These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature, and at the higher pH.

TABLE 1.4— CT VALUES ($CT_{99.9}$) for 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 15.0 °C[1]

Free residual (mg/l)	pH						
	≦6.0	6.5	7.0	7.5	8.0	8.5	≦9.0
≦0.4	49	59	70	83	99	118	140
0.6	50	60	72	86	102	122	146
0.8	52	61	73	88	105	126	151
1.0	53	63	75	90	108	130	156
1.2	54	64	76	92	111	134	160
1.4	55	65	78	94	114	137	165
1.6	56	66	79	96	116	141	169
1.8	57	68	81	98	119	144	173
2.0	58	69	83	100	122	147	177
2.2	59	70	85	102	124	150	181
2.4	60	72	86	105	127	153	184
2.6	61	73	88	107	129	156	188
2.8	62	74	89	109	132	159	191
3.0	63	76	91	111	134	162	195

[1] These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature, and at the higher pH.

TABLE 1.5—CT Values ($CT_{99.9}$) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 20 °C[1]

Free residual (mg/l)	pH						
	≤ 6.0	6.5	7.0	7.5	8.0	8.5	≤ 9.0
≤ 0.4	36	44	52	62	74	89	105
0.6	36	45	54	64	77	92	109
0.8	39	46	55	66	79	95	113
1.0	39	47	56	67	81	98	117
1.2	40	48	57	69	83	100	120
1.4	41	49	58	70	85	103	123
1.6	42	50	59	72	87	105	126
1.8	43	51	61	74	89	108	129
2.0	44	52	62	75	91	110	132
2.2	44	53	63	77	93	113	135
2.4	45	54	65	78	95	115	138
2.6	46	55	66	80	97	117	141
2.8	47	56	67	81	99	119	143
3.0	47	57	68	83	101	122	146

[1] These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature, and at the higher pH.

TABLE 1.6—CT Values ($CT_{99.9}$) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 25 °C[1] AND HIGHER

Free residual (mg/l)	pH						
	≤ 6.0	6.5	7.0	7.5	8.0	8.5	≤ 9.0
≤ 0.4	24	29	35	42	50	59	70
0.6	25	30	36	43	51	61	73
0.8	26	31	37	44	53	63	75
1.0	26	31	37	45	54	65	78
1.2	27	32	38	46	55	67	80
1.4	27	33	39	47	57	69	82

TABLE 1.6—CT Values ($CT_{99.9}$) for 99.9 Percent Inactivation of Giardia Lamblia Cysts by Free Chlorine at 25 °C[1] and Higher—Continued

Free residual (mg/l)	pH						
	≤ 6.0	6.5	7.0	7.5	8.0	8.5	≤ 9.0
1.6	28	33	40	48	58	70	84
1.8	29	34	41	49	60	72	86
2.0	29	35	41	50	61	74	88
2.2	30	35	42	51	62	75	90
2.4	30	36	43	52	63	77	92
2.6	31	37	44	53	65	78	94
2.8	31	37	45	54	66	80	96
3.0	32	38	46	55	67	81	97

[1] These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature, and at the higher pH.

TABLE 2.1—CT Values ($CT_{99.9}$) for 99.9 Percent Inactivation of Giardia Lamblia Cysts by Chlorine Dioxide and Ozone[1]

	Temperature					
	≤ 1 °C	5 °C	10 °C	15 °C	20 °C	≥ 25 °C
Chlorine dioxide	63	26	23	19	15	11
Ozone	2.9	1.9	1.4	0.95	0.72	0.48

[1] These CT values achieve greater than 99.99 percent inactivation of viruses. CT values between the indicated temperatures may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature for determining $CT_{99.9}$ values between indicated temperatures.

TABLE 3.1—CT Values ($CT_{99.9}$) for 99.9 Percent Inactivation of Giardia Lamblia Cysts By Chloramines[1]

Temperature					
≤ 1 °C	5 °C	10 °C	15 °C	20 °C	25 °C
3,800	2,200	1,850	1,500	1,100	750

[1] These values are for pH values of 6 to 9. These CT values may be assumed to achieve greater than 99.99 percent inactivation of viruses only if chlorine is added and mixed in the water prior to the addition of ammonia. If this condition is not met, the system must demonstrate, based on on-site studies or other information, as approved by the State, that the system is achieving at least 99.99 percent inactivation of viruses. CT values between the indicated temperatures may be determined by linear interpolation. If no interpolation is used, use the $CT_{99.9}$ value at the lower temperature for determining $CT_{99.9}$ values between indicated temperatures.

(4) The total inactivation ratio must be calculated as follows:

(i) If the system uses only one point of disinfectant application, the system may determine the total inactivation ratio based on either of the following two methods:

(A) One inactivation ratio ($CTcalc/CT_{99.9}$) is determined before or at the first customer during peak hourly flow and if the $CTcalc/CT_{99.9} \geq 1.0$, the 99.9 percent *Giardia lamblia* inactivation requirement has been achieved; or

(B) Successive $CTcalc/CT_{99.9}$ values, representing sequential inactivation ratios, are determined between the point of disinfectant application and a point before or at the first customer during peak hourly flow. Under this alternative, the following method must be used to calculate the total inactivation ratio:

(1) Determine $\frac{CTcalc}{CT_{99.9}}$ for each sequence.

(2) Add the $\frac{CTcalc}{CT_{99.9}}$ values together $\left(\sum \frac{(CTcalc)}{CT_{99.9}} \right)$

(3) If $\sum \left(\frac{CTcalc}{CT_{99.9}} \right) \geq 1.0$, the 99.9 percent *Giardia lamblia* inactivation requirement has been achieved.

(ii) If the system uses more than one point of disinfectant application before or at the first customer, the system must determine the CT value of each disinfection sequence immediately prior to the next point of disinfectant application during peak hourly flow. The $CTcalc/CT_{99.9}$ value of each sequence and

$$\sum \frac{CTcalc}{CT_{99.9}}$$

must be calculated using the method in paragraph (b)(4)(i)(B) of this section to determine if the system is in compliance with § 142.72(a).

(iii) Although not required, the total percent inactivation for a system with one or more points of residual disinfectant concentration monitoring may be calculated by solving the following equation:

$$\text{Percent inactivation} = 100 - \frac{100}{10^z}$$

where $z = 3 \times \sum \left(\frac{CTcalc}{CT_{99.9}} \right)$

(5) The residual disinfectant concentration of the water entering the

distribution system must be monitored continuously, and the lowest value must be recorded each day, except that if there is a failure in the continuous monitoring equipment, grab sampling every 4 hours may be conducted in lieu of continuous monitoring, but for no more than 5 working days following the failure of the equipment, and systems serving 3,300 or fewer persons may take grab samples in lieu of providing continous monitoring on an ongoing basis at the frequencies prescribed below:

System size by population	Samples/day[1]
< 500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

[1] The day's samples cannot be taken at the same time. The sampling intervals are subject to State review and approval.

If at any time the residual disinfectant concentration falls below 0.2 mg/l in a system using grab sampling in lieu of continuous monitoring, the system must take a grab sample every 4 hours until the residual concentration is equal to or greater than 0.2 mg/l.

(6)(i) The residual disinfectant concentration must be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled, as specified in § 141.21, except that the State may allow a public water system which uses both a surface water source or a ground water source under direct influence of surface water, and a ground water source, to take disinfectant residual samples at points other than the total coliform sampling points if the State determines that such points are more representative of treated (disinfected) water quality within the distribution system. Heterotrophic bacteria, measured as heterotrophic plate count (HPC) as specified in paragraph (a)(3) of this section, may be measured in lieu of residual disinfectant concentration.

(ii) If the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by paragraph (a)(3) of this section and that the system is providing adequate disinfection in the distribution system, the requirements of paragraph (b)(6)(i) of this section do not apply to that system.

(c) *Monitoring requirements for systems using filtration treatment.* A public water system that uses a surface water source or a ground water source under the influence of surface water and provides filtration treatment must monitor in accordance with this paragraph (c) beginning June 29, 1993, or when filtration is installed, whichever is later.

(1) Turbidity measurements as required by § 141.73 must be performed on representative samples of the system's filtered water every four hours (or more frequently) that the system serves water to the public. A public water system may substitute continuous turbidity monitoring for grab sample monitoring if it validates the continuous measurement for accuracy on a regular basis using a protocol approved by the State. For any systems using slow sand filtration or filtration treatment other than conventional treatment, direct filtration, or diatomaceous earth filtration, the State may reduce the sampling frequency to once per day if it determines that less frequent monitoring is sufficient to indicate effective filtration performance. For systems serving 500 or fewer persons, the State may reduce the turbidity sampling frequency to once per day, regardless of the type of filtration treatment used, if the State determines that less frequent monitoring is sufficient to indicate effective filtration performance.

(2) The residual disinfectant concentration of the water entering the distribution system must be monitored continuously, and the lowest value must be recorded each day, except that if there is a failure in the continuous monitoring equipment, grab sampling every 4 hours may be conducted in lieu of continuous monitoring, but for no more than 5 working days following the failure of the equipment, and systems serving 3,300 or fewer persons may take grab samples in lieu of providing continuous monitoring on an ongoing basis at the frequencies each day prescribed below:

System size by population	Samples/day[1]
≤500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

[1] The day's samples cannot be taken at the same time. The sampling intervals are subject to State review and approval.

If at any time the residual disinfectant concentration falls below 0.2 mg/l in a system using grab sampling in lieu of continuous monitoring, the system must take a grab sample every 4 hours until the residual disinfectant concentration is equal to or greater than 0.2 mg/l.

(3)(i) The residual disinfectant concentration must be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled, as specified in § 141.21, except that the State may allow a public water system which uses both a surface water source or a ground water source under direct influence of surface water, and a ground water source to take disinfectant residual samples at points other than the total coliform sampling points if the State determines that such points are more representative of treated (disinfected) water quality within the distribution system. Heterotrophic bacteria, measured as heterotrophic plate count (HPC) as specified in paragraph (a)(3) of this section, may be measured in lieu of residual disinfectant concentration.

(ii) If the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by paragraph (a)(3) of this section and that the system is providing adequate disinfection in the distribution system, the requirements of paragraph (c)(3)(i) of this section do not apply to that system.

§ 141.75 Reporting and recordkeeping requirements.

(a) A public water system that uses a surface water source and does not provide filtration treatment must report monthly to the State the information specified in this paragraph (a) beginning December 31, 1990, unless the State has determined that filtration is required in writing pursuant to section 1412(b)(7)(C)(iii), in which case the State may specify alternative reporting requirements, as appropriate, until filtration is in place. A public water system that uses a ground water source under the direct influence of surface water and does not provide filtration treatment must report monthly to the State the information specified in this paragraph (a) beginning December 31, 1990, or 6 months after the State determines that the ground water source is under the direct influence of surface water, whichever is later, unless the State has determined that filtration is required in writing pursuant to § 1412(b)(7)(C)(iii), in which case the State may specify alternative reporting requirements, as appropriate, until filtration is in place.

(1) Source water quality information must be reported to the State within 10

days after the end of each month the system serves water to the public. Information that must be reported includes:

(i) The cumulative number of months for which results are reported.

(ii) The number of fecal and/or total coliform samples, whichever are analyzed during the month (if a system monitors for both, only fecal coliforms must be reported), the dates of sample collection, and the dates when the turbidity level exceeded 1 NTU.

(iii) The number of samples during the month that had equal to or less than 20/100 ml fecal coliforms and/or equal to or less than 100/100 ml total coliforms, whichever are analyzed.

(iv) The cumulative number of fecal or total coliform samples, whichever are analyzed, during the previous six months the system served water to the public.

(v) The cumulative number of samples that had equal to or less than 20/100 ml fecal coliforms or equal to or less than 100/100 ml total coliforms, whichever are analyzed, during the previous six months the system served water to the public.

(vi) The percentage of samples that had equal to or less than 20/100 ml fecal coliforms or equal to or less than 100/100 ml total coliforms, whichever are analyzed, during the previous six months the system served water to the public.

(vii) The maximum turbidity level measured during the month, the date(s) of occurrence for any measurement(s) which exceeded 5 NTU, and the date(s) the occurrence(s) was reported to the State.

(viii) For the first 12 months of recordkeeping, the dates and cumulative number of events during which the turbidity exceeded 5 NTU, and after one year of recordkeeping for turbidity measurements, the dates and cumulative number of events during which the turbidity exceeded 5 NTU in the previous 12 months the system served water to the public.

(ix) For the first 120 months of recordkeeping, the dates and cumulative number of events during which the turbidity exceeded 5 NTU, and after 10 years of recordkeeping for turbidity measurements, the dates and cumulative number of events during which the turbidity exceeded 5 NTU in the previous 120 months the system served water to the public.

(2) Disinfection information specified in § 141.74(b) must be reported to the State within 10 days after the end of each month the system serves water to the public. Information that must be reported includes:

(i) For each day, the lowest measurement of residual disinfectant concentration in mg/l in water entering the distribution system.

(ii) The date and duration of each period when the residual disinfectant concentration in water entering the distribution system fell below 0.2 mg/l and when the State was notified of the occurrence.

(iii) The daily residual disinfectant concentration(s) (in mg/l) and disinfectant contact time(s) (in minutes) used for calculating the CT value(s).

(iv) If chlorine is used, the daily measurement(s) of pH of disinfected water following each point of chlorine disinfection.

(v) The daily measurement(s) of water temperature in °C following each point of disinfection.

(vi) The daily CTcalc and CTcalc/$CT_{99.9}$ values for each disinfectant measurement or sequence and the sum of all CTcalc/$CT_{99.9}$ values ((CTcalc/$CT_{99.9}$)) before or at the first customer.

(vii) The daily determination of whether disinfection achieves adequate *Giardia* cyst and virus inactivation, i.e., whether (CTcalc/$CT_{99.9}$) is at least 1.0 or, where disinfectants other than chlorine are used, other indicator conditions that the State determines are appropriate, are met.

(viii) The following information on the samples taken in the distribution system in conjunction with total coliform monitoring pursuant to § 141.72:

(A) Number of instances where the residual disinfectant concentration is measured;

(B) Number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;

(C) Number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;

(D) Number of instances where the residual disinfectant concentration is detected and where HPC is >500/ml;

(E) Number of instances where the residual disinfectant concentration is not measured and HPC is >500/ml;:

(F) For the current and previous month the system served water to the public, the value of "V" in the following formula:

$$V = \frac{c+d+e}{a+b} \times 100$$

where

a = the value in paragraph (a)(2)(viii)(A) of this section,

b = the value in paragraph (a)(2)(viii)(B) of this section,

c = the value in paragraph (a)(2)(viii)(C) of this section,

d = the value in paragraph (a)(2)(viii)(D) of this section, and

e = the value in paragraph (a)(2)(viii)(E) of this section.

(G) If the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by § 141.74(a)(3) and that the system is providing adequate disinfection in the distribution system, the requirements of paragraph (a)(2)(viii)(A)–(F) of this section do not apply to that system.

(ix) A system need not report the data listed in paragraphs (a)(2)(i), and (iii)–(vi) of this section if all data listed in paragraphs (a)(2) (i)–(viii) of this section remain on file at the system, and the State determines that:

(A) The system has submitted to the State all the information required by paragraphs (a)(2) (i)–(viii) of this section for at least 12 months; and

(B) The State has determined that the system is not required to provide filtration treatment.

(3) No later than ten days after the end of each Federal fiscal year (September 30), each system must provide to the State a report which summarizes its compliance with all watershed control program requirements specified in § 141.71(b)(2).

(4) No later than ten days after the end of each Federal fiscal year (September 30), each system must provide to the State a report on the on-site inspection conducted during that year pursuant to § 141.71(b)(3), unless the on-site inspection was conducted by the State. If the inspection was conducted by the State, the State must provide a copy of its report to the public water system.

(5)(i) Each system, upon discovering that a waterborne disease outbreak potentially attributable to that water system has occurred, must report that occurrence to the State as soon as possible, but no later than by the end of the next business day.

(ii) If at any time the turbidity exceeds 5 NTU, the system must inform the State as soon as possible, but no later than the end of the next business day.

(iii) If at any time the residual falls below 0.2 mg/l in the water entering the distribution system, the system must notify the State as soon as possible, but no later than by the end of the next business day. The system also must notify the State by the end of the next business day whether or not the residual

was restored to at least 0.2 mg/l within 4 hours.

(b) A public water system that uses a surface water source or a ground water source under the direct influence of surface water and provides filtration treatment must report monthly to the State the information specified in this paragraph (b) beginning June 29, 1993, or when filtration is installed, whichever is later.

(1) Turbidity measurements as required by § 141.74(c)(1) must be reported within 10 days after the end of each month the system serves water to the public. Information that must be reported includes:

(i) The total number of filtered water turbidity measurements taken during the month.

(ii) The number and percentage of filtered water turbidity measurements taken during the month which are less than or equal to the turbidity limits specified in § 141.73 for the filtration technology being used.

(iii) The date and value of any turbidity measurements taken during the month which exceed 5 NTU.

(2) Disinfection information specified in § 141.74(c) must be reported to the State within 10 days after the end of each month the system serves water to the public. Information that must be reported includes:

(i) For each day, the lowest measurement of residual disinfectant concentration in mg/l in water entering the distribution system.

(ii) The date and duration of each period when the residual disinfectant concentration in water entering the distribution system fell below 0.2 mg/l and when the State was notified of the occurrence.

(iii) The following information on the samples taken in the distribution system in conjunction with total coliform monitoring pursuant to § 141.72:

(A) Number of instances where the residual disinfectant concentration is measured;

(B) Number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;

(C) Number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;

(D) Number of instances where no residual disinfectant concentration is detected and where HPC is >500/ml;

(E) Number of instances where the residual disinfectant concentration is not measured and HPC is >500/ml;

(F) For the current and previous month the system serves water to the public, the value of "V" in the following formula:

$$V = \frac{c+d+e}{a+b} \times 100$$

where

a = the value in paragraph (b)(2)(iii)(A) of this section,

b = the value in paragraph (b)(2)(iii)(B) of this section,

c = the value in paragraph (b)(2)(iii)(C) of this section,

d = the value in paragraph (b)(2)(iii)(D) of this section, and

e = the value in paragraph (b)(2)(iii)(E) of this section.

(G) If the State determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory within the requisite time and temperature conditions specified by § 141.74(a)(3) and that the system is providing adequate disinfection in the distribution system, the requirements of paragraph (b)(2)(iii)(A)–(F) of this section do not apply.

(iv) A system need not report the data listed in paragraph (b)(2)(i) of this section if all data listed in paragraphs (b)(2)(i)–(iii) of this section remain on file at the system and the State determines that the system has submitted all the information required by paragraphs (b)(2)(i)–(iii) of this section for at least 12 months.

(3)(i) Each system, upon discovering that a waterborne disease outbreak potentially attributable to that water system has occurred, must report that occurrence to the State as soon as possible, but no later than by the end of the next business day.

(ii) If at any time the turbidity exceeds 5 NTU, the system must inform the State as soon as possible, but no later than the end of the next business day.

(iii) If at any time the residual falls below 0.2 mg/l in the water entering the distribution system, the system must notify the State as soon as possible, but no later than by the end of the next business day. The system also must notify the State by the end of the next business day whether or not the residual was restored to at least 0.2 mg/l within 4 hours.

PART 142—NATIONAL PRIMARY DRINKING WATER REGULATIONS IMPLEMENTATION

1. The authority citation for Part 142 is revised to read as follows:

Authority: 42 U.S.C. 300f, 300g–1, 300g–2, 300g–3, 300g–4, 300g–5, 300g–6, 300j–4, and 300j–9.

2. Section 142.14 is amended by revising paragraph (a) introductory text, (a)(1)(iii), (a)(3) introductory text, (a)(4) and redesignating it as paragraph (a)(6), and by adding new paragraphs (a)(4) and by adding and reserving paragraph (a)(5) to read as follows:

§ 142.14 Records kept by States.

(a) Each State which has primary enforcement responsibility shall maintain records of tests, measurements, analyses, decisions, and determinations performed on each public water system to determine compliance with applicable provisions of State primary drinking water regulations.

(1) * * *

(iii) The analytical results, set forth in a form which makes possible comparison with the limits specified in §§ 141.63, 141.71, and 141.72 of this chapter.

* * * * *

(3) Records of turbidity measurements shall be kept for not less than one year. The information retained must be set forth in a form which makes possible comparison with the limits specified in §§ 141.71 and 141.73 of this chapter. Until June 29, 1993, for any public water system which is providing filtration treatment and until December 30, 1991, for any public water system not providing filtration treatment and not required by the State to provide filtration treatment, records kept must be set forth in a form which makes possible comparison with the limits contained in § 141.13.

(4)(i) Records of disinfectant residual measurements and other parameters necessary to document disinfection effectiveness in accordance with §§ 141.72 and 141.74 of this chapter and the reporting requirements of § 141.75 of this chapter shall be kept for not less than one year.

(ii) Records of decisions made on a system-by-system and case-by-case basis under provisions of Part 141, Subpart H, shall be made in writing and kept at the State.

(A) Records of decisions made under the following provisions shall be kept for 40 years (or until one year after the decision is reversed or revised) and a copy of the decision must be provided to the system:

(*1*) Section 141.73(a)(1)—Any decision to allow a public water system using conventional filtration treatment or direct filtration to substitute a turbidity limit greater than 0.5 NTU;

(*2*) Section 141.73(b)(1)—Any decision to allow a public water system using

slow sand filtration to substitute a turbidity limit greater than 1 NTU;

(3) Section 141.74(b)(2)—Any decision to allow an unfiltered public water system to use continuous turbidity monitoring;

(4) Section 141.74(b)(6)(i)—Any decision to allow an unfiltered public water system to sample residual disinfectant concentration at alternate locations if it also has ground water source(s);

(5) Section 141.74(c)(1)—Any decision to allow a public water system using filtration treatment to use continuous turbidity monitoring; or a public water system using slow sand filtration or filtration treatment other than conventional treatment, direct filtration or diatomaceous earth filtration to reduce turbidity sampling to once per day; or for systems serving 500 people or fewer to reduce turbidity sampling to once per day;

(6) Section 141.74(c)(3)(i)—Any decision to allow a filtered public water system to sample disinfectant residual concentration at alternate locations if it also has ground water source(s);

(7) Section 141.75(a)(2)(ix)—Any decision to allow reduced reporting by an unfiltered public water system; and

(8) Section 141.75(b)(2)(iv)—Any decision to allow reduced reporting by a filtered public water system.

(B) Records of decisions made under the following provisions shall be kept for one year after the decision is made:

(1) Section 141.71(b)(1)(i)—Any decision that a violation of monthly CT compliance requirements was caused by circumstances that were unusual and unpredictable.

(2) Section 141.71(b)(1)(iv)—Any decision that a violation of the disinfection effectiveness criteria was not caused by a deficiency in treatment of the source water;

(3) Section 141.71(b)(5)—Any decision that a violation of the total coliform MCL was not caused by a deficiency in treatment of the source water;

(4) Section 141.74(b)(1)—Any decision that total coliform monitoring otherwise required because the turbidity of the source water exceeds 1 NTU is not feasible, except that if such decision allows a system to avoid monitoring without receiving State approval in each instance, records of the decision shall be kept until one year after the decision is rescinded or revised.

(C) Records of decisions made under the following provisions shall be kept for the specified period or 40 years, whichever is less.

(1) Section 141.71(a)(2)(i)—Any decision that an event in which the source water turbidity which exceeded 5 NTU for an unfiltered public water system was unusual and unpredictable shall be kept for 10 years.

(2) Section 141.71(b)(1)(iii)—Any decision by the State that failure to meet the disinfectant residual concentration requirements of § 141.72(a)(3)(i) was caused by circumstances that were unusual and unpredictable, shall be kept unless filtration is installed. A copy of the decision must be provided to the system.

(3) Section 141.71(b)(2)—Any decision that a public water system's watershed control program meets the requirements of this section shall be kept until the next decision is available and filed.

(4) Section 141.70(c)—Any decision that an individual is a qualified operator for a public water system using a surface water source or a ground water source under the direct influence of surface water shall be maintained until the qualification is withdrawn. The State may keep this information in the form of a list which is updated periodically. If such qualified operators are classified by category, the decision shall include that classification.

(5) Section 141.71(b)(3)—Any decision that a party other than the State is approved by the State to conduct on-site inspections shall be maintained until withdrawn. The State may keep this information in the form of a list which is updated periodically.

(6) Section 141.71(b)(4)—Any decision that an unfiltered public water system has been identified as the source of a waterborne disease outbreak, and, if applicable, that it has been modified sufficiently to prevent another such occurrence shall be kept until filtration treatment is installed. A copy of the decision must be provided to the system.

(7) Section 141.72—Any decision that certain interim disinfection requirements are necessary for an unfiltered public water system for which the State has determined that filtration is necessary, and a list of those requirements, shall be kept until filtration treatment is installed. A copy of the requirements must be provided to the system.

(8) Section 141.72(a)(2)(ii)—Any decision that automatic shut-off of delivery of water to the distribution system of an unfiltered public water system would cause an unreasonable risk to health or interfere with fire protection shall be kept until rescinded.

(9) Section 141.72(a)(4)(ii)—Any decision by the State, based on site-specific considerations, that an unfiltered system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by § 141.74(a)(3) and that the system is providing adequate disinfection in the distribution system, so that the disinfection requirements contained in § 141.72(a)(4)(i) do not apply, and the basis for the decision, shall be kept until the decision is reversed or revised. A copy of the decision must be provided to the system.

(10) Section 141.72(b)(3)(ii)—Any decision by the State, based on site-specific conditions, that a filtered system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by § 141.74(a)(3) and that the system is providing adequate disinfection in the distribution system, so that the disinfection requirements contained in § 141.72(b)(3)(i) do not apply, and the basis for the decision, shall be kept until the decision is reversed or revised. A copy of the decision must be provided to the system.

(11) Section 141.73(d)—Any decision that a public water system, having demonstrated to the State that an alternative filtration technology, in combination with disinfection treatment, consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses, may use such alternative filtration technology, shall be kept until the decision is reversed or revised. A copy of the decision must be provided to the system.

(12) Section 141.74(b), Table 3.1—Any decision that a system using either preformed chloramines or chloramines formed by the addition of ammonia prior to the addition of chlorine has demonstrated that 99.99 percent removal and/or inactivation of viruses has been achieved at particular CT values, and a list of those values, shall be kept until the decision is reversed or revised. A copy of the list of required values must be provided to the system.

(13) Section 141.74(b)(3)(v)—Any decision that a system using a disinfectant other than chlorine may use $CT_{99.9}$ values other than those in Tables 2.1 or 3.1 and/or other operational parameters to determine if the minimum total inactivation rates required by § 141.72(a)(1) are being met, and what those values or parameters are, shall be kept until the decision is reversed or revised. A copy of the list of required values or parameters must be provided to the system.

(14) Section 142.16(b)(2)(i)(B)—Any decision that a system using a ground water source is under the direct influence of surface water.

(iii) Records of any determination that a public water system supplied by a surface water source or a ground water source under the direct influence of surface water is not required to provide filtration treatment shall be kept for 40 years or until withdrawn, whichever is earlier. A copy of the determination must be provided to the system.

(5) [Reserved]

(6) Records of analyses for contaminants other than microbiological contaminants (including total coliform, fecal coliform, and heterotrophic plate count), residual disinfectant concentration, other parameters necessary to determine disinfection effectiveness (including temperature and pH measurements), and turbidity, must be retained for not less than 40 years and shall include at least the following information:

(i) Date and place of sampling.

(ii) Date and results of analyses.

* * * * *

3. Section 142.15 is amended by adding paragraphs (b)(3) and (4) and paragraph (e) to read as follows:

§ 142.15 Reports by States.

* * * * *

(b) * * *

(3) A list identifying the name, PWS identification number and date of the determination for each public water system supplied by a surface water source or a ground water source under the direct influence of surface water, which the State has determined is not required to provide filtration treatment.

(4) A list identifying the name and PWS identification number of each public water system supplied by a surface water source or ground water source under the direct influence of surface water, which the State has determined, based on an evaluation of site-specific considerations, has no means of having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified in § 141.74(a)(3) and is providing adequate disinfection in the distribution system, regardless of whether the system is in compliance with the criteria of § 141.72(a)(4)(i) or (b)(3)(i) of this chapter, as allowed by § 141.72(a)(4)(ii) and (b)(3)(ii). The list must include the effective date of each determination.

* * * * *

(e) Notification within 60 days of the end of the calendar quarter of any determination that a public water system using a surface water source or a ground water source under the direct influence of surface water is not required to provide filtration treatment. The notification must include a statement describing the system's compliance with each requirement of the State's regulations that implement § 141.71 and a summary of comments, if any, received from the public on the determination. A single notification may be used to report two or more such determinations.

4. Section 142.16 is amended by adding paragraph (b) to read as follows:

§ 142.16 Special primacy requirements.

* * * * *

(b) *Requirements for States to adopt 40 CFR Part 141, Subpart H Filtration and Disinfection.* In addition to the general primacy requirements enumerated elsewhere in this part, including the requirement that State provisions are no less stringent than the federal requirements, an application for approval of a State program revision that adopts 40 CFR Part 141, Subpart H Filtration and Disinfection, must contain the information specified in this paragraph (b), except that States which require without exception all public water systems using a surface water source or a ground water source under the direct influence of surface water to provide filtration need not demonstrate that the State program has provisions that apply to systems which do not provide filtration treatment. However, such States must provide the text of the State statutes or regulations which specifies that all public water systems using a surface water source or a ground water source under the direct influence of surface water must provide filtration.

(1) *Enforceable requirements.* In addition to adopting criteria no less stringent than those specified in Part 141, Subpart H of this chapter, the State's application must include enforceable design and operating criteria for each filtration treatment technology allowed or a procedure for establishing design and operating conditions on a system-by-system basis (e.g., a permit system).

(2) *State practices or procedures.* (i) A State application for program revision approval must include a description of how the State will accomplish the following:

(A) Section 141.70(c) (qualification of operators)—Qualify operators of systems using a surface water source or a ground water source under the direct influence of surface water.

(B) Determine which systems using a ground water source are under the direct influence of surface water by June 29, 1994 for community water systems and by June 29, 1999 for non-community water systems.

(C) Section 141.72(b)(1) (achieving required *Giardia lamblia* and virus removal in filtered systems)—Determine that the combined treatment process incorporating disinfection treatment and filtration treatment will achieve the required removal and/or inactivation of *Giardia lamblia* and viruses.

(D) Section 141.74(a) (State approval of parties to conduct analyses)—approve parties to conduct pH, temperature, turbidity, and residual disinfectant concentration measurements.

(E) Determine appropriate filtration treatment technology for source waters of various qualities.

(ii) For a State which does not require all public water systems using a surface water source or ground water source under the direct influence of surface water to provide filtration treatment, a State application for program revision approval must include a description of how the State will accomplish the following:

(A) Section 141.71(b)(2) (watershed control program)—Judge the adequacy of watershed control programs.

(B) Section 141.71(b)(3) (approval of on-site inspectors)—Approve on-site inspectors other than State personnel and evaluate the results of on-site inspections.

(iii) For a State which adopts any of the following discretionary elements of Part 141 of this chapter, the application must describe how the State will:

(A) Section 141.72 (interim disinfection requirements)—Determine interim disinfection requirements for unfiltered systems which the State has determined must filter which will be in effect until filtration is installed.

(B) Section 141.72(a)(4)(ii) and (b)(3)(ii) (determination of adequate disinfection in system without disinfectant residual)—Determine that a system is unable to measure HPC but is still providing adequate disinfection in the distribution system, as allowed by § 141.72(a)(4)(ii) for systems which do not provide filtration treatment and § 141.72(b)(3)(ii) for systems which do provide filtration treatment.

(C) Section 141.73(a)(1) and (b)(1) (alternative turbidity limit)—Determine whether an alternative turbidity limit is appropriate and what the level should be as allowed by § 141.73(a)(1) for a system using conventional filtration treatment or direct filtration and by § 141.73(b)(1) for a system using slow sand filtration.

(D) Section 141.73(d) (alternative filtration technologies)—Determine that a public water system has demonstrated that an alternate filtration technology, in

combination with disinfection treatment, achieves adequate removal and/or disinfection of *Giardia lamblia* and viruses.

(E) Section 141.74(a)(5) (alternate analytical method for chlorine)—Approve DPD colorimetric test kits for free and combined chlorine measurement or approve calibration of automated methods by the Indigo Method for ozone determination.

(F) Section 141.74 (b)(2) and (c)(1) (approval of continuous turbidity monitoring)—Approve continuous turbidity monitoring, as allowed by § 141.74(b)(2) for a public water system which does not provide filtration treatment and § 141.74(c)(1) for a system which does provide filtration treatment.

(G) Section 141.74 (b)(6)(i) and (c)(3)(i) (approval of alternate disinfectant residual concentration sampling plans)—Approve alternate disinfectant residual concentration sampling plans for systems which have a combined ground water and surface water or ground water and ground water under the direct influence of a surface water distribution system, as allowed by § 141.74(b)(6)(i) for a public water system which does not provide filtration treatment and § 141.74(c)(3)(i) for a public water system which does provide filtration treatment.

(H) Section 141.74(c)(1) (reduction of turbidity monitoring)—Decide whether to allow reduction of turbidity monitoring for systems using slow sand filtration, an approved alternate filtration technology or serving 500 people or fewer.

(I) Section 141.75 (a)(2)(ix) and (b)(2)(iv) (reduced reporting)—Determine whether reduced reporting is appropriate, as allowed by § 141.75(a)(2)(ix) for a public water system which does not provide filtration treatment and § 141.75(b)(2)(iv) for a public water system which does provide filtration treatment.

(iv) For a State which does not require all public water systems using a surface water source or ground water source under the direct influence of surface water to provide filtration treatment and which uses any of the following discretionary provisions, the application must describe how the State will:

(A) Section 141.71(a)(2)(i) (source water turbidity requirements)—Determine that an exceedance of turbidity limits in source water was caused by circumstances that were unusual and unpredictable.

(B) Section 141.71(b)(1)(i) (monthly CT compliance requirements)—Determine whether failure to meet the requirements for monthly CT compliance in § 141.72(a)(1) was caused by circumstances that were unusual and unpredictable.

(C) Section 141.71(b)(1)(iii) (residual disinfectant concentration requirements)—Determine whether failure to meet the requirements for residual disinfectant concentration entering the distribution system in § 141.72(a)(3)(i) was caused by circumstances that were unusual and unpredictable.

(D) Section 141.71(b)(1)(iv) (distribution system disinfectant residual concentration requirements)—Determine whether failure to meet the requirements for distribution system residual disinfectant concentration in § 141.72(a)(4) was related to a deficiency in treatment.

(E) Section 141.71(b)(4) (system modification to prevent waterborne disease outbreak)—Determine that a system, after having been identified as the source of a waterborne disease outbreak, has been modified sufficiently to prevent another such occurrence.

(F) Section 141.71(b)(5) (total coliform MCL)—Determine whether a total coliform MCL violation was caused by a deficiency in treatment.

(G) Section 141.72(a)(1) (disinfection requirements)—Determine that different ozone, chloramine, or chlorine dioxide $CT_{99.9}$ values or conditions are adequate to achieve required disinfection.

(H) Section 141.72(a)(2)(ii) (shut-off of water to distribution system)—Determine whether a shut-off of water to the distribution system when the disinfectant residual concentration entering the distribution system is less than 0.2 mg/1 will cause an unreasonable risk to health or interfere with fire protection.

(I) Section 141.74(b)(1) (coliform monitoring)—Determine that coliform monitoring which otherwise might be required is not feasible for a system.

(J) Section 141.74(b), Table 3.1 (disinfection with chloramines)—Determine the conditions to be met to insure 99.99 percent removal and/or inactivation of viruses in systems which use either preformed chloramines or chloramines for which ammonia is added to the water before chlorine, as allowed by Table 3.1.

5. New § 142.64 is added to read as follows:

§ 142.64 Variances and exemptions from the requirements of Part 141, Subpart H—Filtration and Disinfection.

(a) No variances from the requirements in Part 141, Subpart H are permitted.

(b) No exemptions from the requirements in § 141.72(a)(3) and (b)(2) to provide disinfection are permitted.

6. Subpart I is added to read as follows:

Subpart I—Administrator's Review of State Decisions that Implement Criteria Under Which Filtration is Required

Sec.

Subpart I—Administrator's Review of State Decisions that Implement Criteria Under Which Filtration Is Required

§ 142.60 Review procedures.

(a) The Administrator may initiate a comprehensive review of the decisions made by States with primary enforcement responsibility to determine, in accordance with § 141.71 of this chapter, if public water systems using surface water sources must provide filtration treatment. The Administrator shall complete this review within one year of its initiation and shall schedule subsequent reviews as (s)he deems necessary.

(b) EPA shall publish notice of a proposed review in the **Federal Register**. Such notice must:

(1) Provide information regarding the location of data and other information pertaining to the review to be conducted and other information including new scientific matter bearing on the application of the criteria for avoiding filtration; and

(2) Advise the public of the opportunity to submit comments.

(c) Upon completion of any such review, the Administrator shall notify each State affected by the results of the review and shall make the results available to the public.

§ 142.61 Notice to the State.

(a) If the Administrator finds through periodic review or other available information that a State (1) has abused its discretion in applying the criteria for avoiding filtration under § 141.71 of this chapter in determining that a system does not have to provide filtration treatment, or (2) has failed to prescribe compliance schedules for those systems which must provide filtration in accordance with section 1412(b)(7)(C)(ii) of the Act, (s)he shall notify the State of these findings. Such notice shall:

(1) Identify each public water system for which the Administrator finds the State has abused its discretion;

(2) Specify the reasons for the finding;

(3) As appropriate, propose that the criteria of § 141.71 of this chapter be applied properly to determine the need for a public water system to provide filtration treatment or propose a revised

schedule for compliance by the public water system with the filtration treatment requirements;

(b) The Administrator shall also notify the State that a public hearing is to be held on the provisions of the notice required by paragraph (a) of this section. Such notice shall specify the time and location of the hearing. If, upon notification of a finding by the Administrator that the State has abused its discretion under § 141.71 of this chapter, the State takes corrective action satisfactory to the Administrator, the Administrator may rescind the notice to the State of a public hearing.

(c) The Administrator shall publish notice of the public hearing in the **Federal Register** and in a newspaper of general circulation in the involved State, including a summary of the findings made pursuant to paragraph (a) of this section, a statement of the time and location for the hearing, and the address and telephone number of an office at which interested persons may obtain further information concerning the hearing.

(d) Hearings convened pursuant to paragraphs (b) and (c) of this section shall be conducted before a hearing officer to be designated by the Administrator. The hearing shall be conducted by the hearing officer in an informal, orderly, and expeditious manner. The hearing officer shall have the authority to call witnesses, receive oral and written testimony, and take such other action as may be necessary to ensure the fair and efficient conduct of the hearing. Following the conclusion of the hearing, the hearing officer may make a recommendation to the Administrator based on the testimony presented at the hearing and shall forward any such recommendation and the record of the hearing to the Administrator.

(e) Within 180 days after the date notice is given pursuant to paragraph (b) of this section, the Administrator shall:

(1) Rescind the notice to the State of a public hearing if the State takes corrective action satisfactory to the Administrator; or

(2) Rescind the finding for which the notice was given and promptly notify the State of such rescission; or

(3) Uphold the finding for which the notice was given. In this event, the Administrator shall revoke the State's decision that filtration was not required or revoke the compliance schedule approved by the State, and promulgate, as appropriate, with any appropriate modifications, a revised filtration decision or compliance schedule and promptly notify the State of such action.

(f) Revocation of a State's filtration decision or compliance schedule and/or promulgation of a revised filtration decision or compliance schedule shall take effect 90 days after the State is notified under paragraph (e)(3) of this section.

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