



Disinfection in a Community Water System: A Guide for Tennessee Municipal Elected Officials

Part 4 of a 6 Part Series

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Disinfection is a process that the utility uses to inactivate the pathogens which could exist within the source water or be introduced into the water system. In Tennessee the approved disinfectant which must be injected into the finished water supply is **chlorine**.

To achieve disinfection the utility must provide adequate disinfectant in the water and adequate contact time for the disinfectant to inactivate the pathogen. The level of chlorine and required contact time is specified by the Tennessee Department of Environment and Conservation (TDEC). TDEC requires at least two feed systems at the water treatment plant as a redundancy factor. Every sample taken for microbial analysis also has a chlorine test to check residual levels at the distribution point.

Rules of Tennessee Department of Environment and Conservation. Division of Water Resources. Chapter 0400-45-01 Public Water Systems

Recommended disinfection agent and minimum chlorine level within the distribution system.

Rule 0400-45-01-17 Operation and Maintenance Requirements

Rule 0400-45-01-17 (4) Chlorine is the recommended disinfection agent. Other agents will be considered by the Department provided they are effective and testing procedures for their effectiveness are recognized in the latest edition of “Standard Methods for the Examination of Water and Wastewater”. All community water systems, using ground water as a raw water source and serving more than 50 connections or 150 persons shall continuously chlorinate (unless other disinfection methods are approved) and shall maintain a free chlorine residual in all parts of the distribution system in the amount of not less than 0.2 mg/l. Public Water Systems using surface water shall continuously chlorinate and maintain a free chlorine residual of 0.2 mg/l in all parts of the distribution system. The residual disinfectant concentration specified by this rule shall not be less than 0.2 mg/l in more than 5 percent of the samples each month, for any two consecutive months the system serves water to the public. All public water systems serving 50 or fewer connections that do not disinfect shall install continuous disinfection if the system fails to comply with the maximum contaminant level for coliform, experiences a disease outbreak or is directed to install disinfection by the department.

Rule 0400-45-01-06 Maximum Contaminant Levels

(6) (c) Maximum residual disinfectant levels.

1. Maximum residual disinfectant levels (MRDLs) are as follows:

Disinfectant residual	MRDL (mg/L)
Chlorine.....	4.0 (as Cl ₂).
Chloramines.....	4.0 (as Cl ₂).
Chlorine dioxide.....	0.8 (as ClO ₂).

Rule 0400-45-01-.04 Definitions

(21) “CT” or “CTcalc” is the product of “residual disinfectant concentration” (C) in mg/1 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). “CT99.9” is the CT value required for 99.9 percent (3 log) inactivation of *Giardia lamblia* cysts. CT99.9 for a variety of disinfectants and conditions appear in Tables 1.1 through 1.6, 2.1, and 3.1 of part (5)(b)3. of Rule 0400-45-01-.31.

$$\frac{CT_{calc}}{CT_{99.9}}$$

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

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

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* cyst. Disinfectant concentrations must be determined by tracer studies or an equivalent demonstration approved by the Department.

(25) “Disinfectant” means any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms.

(26) “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.

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

(28) "Disinfection profile" is a summary of daily *Giardia lamblia* inactivation through the treatment plant. The procedure for developing a disinfection profile is contained in 40 CFR 141.172.

Rule 0400-45-01-17 Operation and Maintenance Requirements

(28) All public water systems using surface water shall provide disinfection to control the biological quality of the water. Due consideration shall be given to the contact time of the disinfectant in the water with relation to pH, ammonia, taste producing substances, temperature, presence and type of pathogens, and trihalomethane formation potential. All disinfection basins must be designed to prevent water short-circuiting the system. The disinfectant will be applied in the manner needed to provide adequate contact time.

(29) All community water systems using ground water as the raw water source serving water to more than 50 connections or 150 people will apply the disinfectant in the manner needed for time. Contact time for ground water systems shall not be less than 15 minutes prior to the first customer.

Log Removal Requirements

Rule 0400-45-01-17

(30) Any surface supplied water system or ground water systems under the direct influence of surface water required to filter shall employ filtration in combination with disinfection that will achieve 99.9% (3 log) and 99.99% (4 log) inactivation of *Giardia lamblia* and viruses respectively 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. For the purposes of determining removal or inactivation efficiencies for *Giardia lamblia* and viruses Table 0400-45-01-17(30)1. and 0400-45-01-17(30)2. shall apply. The free residual disinfectant concentration in the water entering the distribution system cannot be less than 0.2 mg/l for more than four hours.

TABLE 0400-45-01-17(30)1.

Assumed Log Removals by Filtration Method and Required Levels of Disinfection
Treatment Assumed Log Removal Required Minimum Level of Disinfection

	Giardia	Viruses	Giardia	Viruses
Conventional filtration	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 0400-45-01-17(30)2.

CT Values for Achieving 1-Log Inactivation of Giardia Cysts ¹

	pH	Temperature			
		0.5°C	5°C	10°C	15°C
Free Chlorine ^{2, 3}	6	55	39	29	19
	7	79	55	41	26
	8	115	81	61	41
	9	167	118	88	59
Ozone		0.97	0.63	0.48	0.32
Chlorine dioxide		1270	735	615	500

¹ Values to achieve 0.5 log inactivation are one half those shown in the table.

² CT values are for 2.0 mg/l free chlorine.

³ CT values for other concentrations of free chlorine may be taken from Appendix E of the guidance manual for Compliance with the "Filtration and Disinfection Requirements For Public Water Systems Using Surface Water Sources," October, 1989, Edition, Science and Technology Branch Criteria and Standards Division, Office of Drinking Water, USEPA, Washington, D.C.

(31) Each public water system must certify annually in writing to the Department that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified as follows:

Acrylamide = 0.05% dosed at 1 ppm (or equivalent)

Epichlorohydrin = 0.01% dosed at 20 ppm (or equivalent)

Public water systems can rely on manufacturer's or third parties' certification for complying with this requirement.

Source

Rules of Tennessee Department of Environment and Conservation. Division of Water Resources. Chapter 0400-45-01.

<https://publications.tnsosfiles.com/rules/0400/0400-45/0400-45-01.20190217.pdf>



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