CHAPTER 3
DRINKING WATER

C3.1 SCOPE

This chapter contains the Final Governing Standards (FGS) for providing potable water on Department of Defense (DoD) installations in the Federal Republic of Germany.

C3.2 TERMS AND DEFINITIONS

Action Level. The concentration of a substance in water that establishes appropriate treatment for a water system.

Appropriate DoD Medical Authority. The medical professional designated by the in-theater component commander to be responsible for resolving medical issues necessary to provide safe drinking water at the component's installations.

Community Water System (CWS). A public water system having at least 15 service connections used by year-round residents or which regularly serves at least 25 year-round residents.

Concentration/Time (CT). 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. CT values appear in Tables C3.T12. through C3.T25.

Conventional Treatment. Water treatment including chemical coagulation, flocculation, sedimentation, and filtration.

Diatomaceous Earth Filtration. A water treatment process of passing water through a precoat of diatomaceous earth deposited on a support membrane while additional diatomaceous earth is continuously added to the feed water to maintain the permeability of the precoat, resulting in substantial particulate removal from the water.

DIN. *Deutsches Institut für Normung, e.V.* German Institute for Standardization, registered association.

Direct Filtration. Water treatment including chemical coagulation, possibly flocculation, and filtration, but not sedimentation.

Disinfectant. Any oxidant, including but not limited to, chlorine, chlorine dioxide, chloramines, and ozone, intended to kill or inactivate pathogenic microorganisms in water.

DoD Produced Water. Any water used as drinking water where the raw water is extracted by DoD components. If DoD components blend raw water with purchased water, the drinking water is considered DoD produced water. Any drinking water that does not meet the definition of purchased water must be considered DoD produced water.

DoD Water System. A public water system or non-public water system.

DVGW. *Deutsche Vereinigung des Gas- und Wasserfaches e.V. – Technisch-wissenschaftlicher Verein.* German association on gas and water, registered association – technical-scientific association.

Emergency Assessment. An evaluation of the susceptibility of the water source, treatment, storage and distribution system(s) to disruption of service from natural disasters, accidents, and sabotage.

First Draw Sample. A one-liter sample of tap water that has been standing in plumbing at least six hours and is collected without flushing the tap.

Groundwater Under the Direct Influence of Surface Water (GWUDISW). Any water below the surface of the ground with significant occurrence of insects or other microorganisms, algae, or large diameter pathogens such as *Giardia lamblia*; or significant and relatively rapid shifts in water characteristics, such as turbidity, temperature, conductivity, or pH, which closely correlate to climatological or surface water conditions.

Installation. A base, camp, post, station, yard, center, or other activity under the jurisdiction of the Secretary of a Military Department that is located outside the United States and outside any territory, Commonwealth, or possession of the United States.

Lead-free. A maximum lead content of 0.2% for solder and flux, and 8.0% for pipes and fittings.

Lead Service Line. A service line made of lead that connects the water main to the building inlet, and any lead pigtail, gooseneck, or other fitting that is connected to such line.

Maximum Contaminant Level (MCL). The maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system except for turbidity for which the maximum permissible level is measured after filtration. Contaminants added to the water under circumstances controlled by the user, except those resulting from the corrosion of piping and plumbing caused by water quality, are excluded.

Non-Public Water System (NPWS). A system that does not meet the definition of a public water system; for example, a well serving a building with less than 25 people.

Point-of-Entry (POE) Treatment Device. A treatment device applied to the drinking water entering a facility to reduce contaminants in drinking water throughout the facility.

Point-of-Use (POU) Treatment Device. A treatment device applied to a tap to reduce contaminants in drinking water at that tap.

Potable Water. Water that has been examined and treated to meet the standards in this Chapter, and has been approved as potable by the appropriate DoD medical authority.

Public Water System (PWS). A system for providing piped water to the public for human consumption, if such system has at least 15 service connections or regularly serves at least 25 year round residents. This term includes both "community water systems" that serve year-round residents and "non-community systems" along with any collection, treatment, storage, and

distribution facilities under control of the operator of such systems, and any collection or pretreatment storage facilities not under such control that are used primarily in connection with such systems. A non-community system is used by intermittent users or travelers and is sub-classified into a non-transient, non-community (NTNC) system and a transient, non-community (TNC) system. A NTNC system could be a school or factory with its own water supply where the same people drink the water throughout the year, but not 24-hours a day. A TNC system example is a motel with its own well.

Purchased Water. Any drinking water that is acquired from a regulated water supplier authorized by the appropriate German authorities to produce and distribute drinking water.

Sanitary Survey. An on-site review of the water source, facilities, equipment, operation and maintenance of a public water system to evaluate the adequacy of such elements for producing and distributing potable water.

Slow Sand Filtration. Water treatment process where raw water passes through a bed of sand at a low velocity (1.2 ft/hr), resulting in particulate removal by physical and biological mechanisms.

Total Trihalomethanes. The sum of the concentration in mg/L of chloroform, bromoform, dibromochloromethane, and bromodichloromethane.

Underground Injection. A subsurface emplacement through a bored, drilled, driven or dug well where the depth is greater than the largest surface dimension, whenever a principle function of the well is the emplacement of any fluid.

Vulnerability Assessment. An evaluation by DoD that shows contaminants of concern either have not been used in a watershed area or the source of water for the system is not susceptible to contamination. Susceptibility is based on prior occurrence, vulnerability assessment results, environmental persistence and transport of the contaminants, and any wellhead protection program results.

C3.3.1 GENERAL REQUIREMENTS

DoD water systems, regardless of whether they produce or purchase water, will:

C3.3.1.1 Maintain a map/drawing of the complete potable water system.

C3.3.1.2 Update the potable water system master plan when changes occur to the system, at a minimum, an update should performed every 5 years.

C3.3.1.3 Protect all water supply aquifers (groundwater) and surface water sources from contamination by suitable placing of the new intake (heading) to all water treatment facilities; by siting and maintenance of septic systems and on-site treatment units, by appropriate land use management on DoD installations; and by suitable placement and construction of wells.

C3.3.1.3.1 Water protection zones should be established in coordination with the Installation Commander incorporating the following zoning criteria to facilitate the protection of water supply aquifers and surface waters.

Zone I: Well Head Protection Area (*Fassungsbereich*), minimum 10 meters from the well head, in the case of negative subsoil surroundings up to 50 meters towards the arriving groundwater. In Zone I the following activities are forbidden:

- All the activities named for Zone II and III; and
- Any vehicle or pedestrian traffic.

Zone II: Closer Protection Zone (*Engere Schutzzone*), from the limit of Zone I to a line from which the groundwater needs around 50 days to reach the well head. In Zone II the following activities are forbidden:

- The open storage and/or use of water and/or soil damaging chemicals for plant protection;
- To construct or change drains and receiving water drenches;
- To operate ditches and surface waters which carry wastewater or water damaging substances;
- To treat, store, or deposit waste or wastewater, including sludge;
- To store radioactive or other water damaging substances;
- To operate tank farms, cargo terminals and/or storage facilities for heating oil and all other radioactive or water damaging substances, including related traffic;
- To operate long distance pipelines for water damaging substances;
- To transport water damaging substances;
- To operate wastewater collection systems (including all piping systems);
- To leach or infiltrate wastewater;
- To operate wastewater mines (i.e., underground injection wells);
- To leach or infiltrate water coming from streets or traffic areas;
- To install or enlarge sewage treatment plants;
- To operate storage lots for wrecked cars or scrap metal from vehicles;
- Departure, landing, and security areas as well as emergency landing areas or emergency fuel unloading areas for air traffic;
- To wash cars or perform oil changes;
- To construct or enlarge sports fields;
- To construct or enlarge installations that produce, use, store, turn over or treat radioactive and water damaging waste or wastewater;

- To construct or enlarge any other installations (e.g., houses, hospitals, shops, etc.);
- To operate construction sites and building material storage areas;
- To conduct maneuvers and exercises by troops and other organizations;
- Military installations;
- To operate chain tracked vehicles (e.g., combat tanks);
- To store or operate fuel tank trucks; and
- To conduct mobile refueling of vehicles from tank trucks.

Zone III: Wider Protection Zone (*Weitere Schutzzone*), from the limit of Zone II up to the limit of the catchment area of the used water supplies. If the Zone II area limit is greater than two kilometers distance from the limit of the catchment area, the Zone III area can be divided into Zone IIIA and Zone IIIB with the latter being the catchment area beyond two kilometers from the Zone II area limit.

In Zone III B the following activities are forbidden:

- To leach or infiltrate water coming from streets or traffic areas;
- To leach or infiltrate wastewater;
- To operate long distance pipelines containing water damaging substances;
- To store radioactive or other water damaging substances; and
- To construct or enlarge installations that produce, use, store, turn over or treat radioactive and water damaging waste or wastewater.

In Zone III A the activities mentioned in Zone III B are forbidden, as well as:

- The open storage and/or use of water and/or soil damaging chemicals for plant protection;
- To treat, store, or deposit waste or wastewater, including sludge;
- To operate tank farms, cargo terminals and/or storage facilities for heating oil, and all other radioactive or water damaging substances; including all related traffic;
- To transport water damaging substances over the inflow;
- To operate wastewater collection systems, including all piping systems;
- To install or enlarge sewage plants;
- To operate storage lots for wrecked cars or scrap metal from vehicles;

- To use water damaging, leachable, and/or erodable substances for roads, paths, or stormwater collection systems;
- Departure, landing, and security areas as well as emergency landing areas or emergency fuel unloading areas for air traffic;
- To construct or enlarge any other installation (e.g., houses, hospitals, shops, etc.);
- To conduct maneuvers and exercises by military troops or other organizations;
- Military installations;
- To store or operate fuel tank trucks; and
- To conduct mobile refueling of vehicles from tank trucks.

If Zone III is not subdivided the criteria for Zone III A apply.

If any of these zones are present on the installation, measures shall be taken to ensure these areas are properly marked and protected.

C3.3.1.4 Conduct sanitary surveys of the water system at least every 3 years for systems using surface water, and every 5 years for systems using groundwater, or as warranted, including review of required water quality analyses. Off-installation surveys will be coordinated with host nation authorities.

C3.3.1.5 Provide proper treatment for all water sources. Water systems distributing DoD produced water using surface water supplies, including GWUDISW, must conform to the surface water treatment requirements set forth in Table C3.T1, including primary disinfection requirements (i.e. disinfection requirements focused on inactivating or removing microbiological contaminants from raw water to produce microbiologically safe treated water; primary disinfection is typically conducted in a water treatment plant).

C3.3.1.6 Maintain a continuous positive pressure of at least 20 psi in the water distribution system.

C3.3.1.7 Perform water distribution system operation and maintenance practices consisting of:

C3.3.1.7.1 A detectable disinfectant residual shall be maintained throughout the water distribution system except where determined unnecessary by the appropriate DoD medical authority (the maintenance of a disinfectant residual is often referred to as either secondary disinfection or safety chlorination and involves maintaining a disinfectant concentration, usually chlorine, throughout the distribution system; secondary disinfection is typically done downstream of the initial water plant treating raw water).

C3.3.1.7.2 Proper procedures for repair and replacement of mains (including disinfection and bacteriological testing).

C3.3.1.7.3 An effective annual water main flushing program.

C3.3.1.7.4 Proper operation and maintenance of storage tanks and reservoirs.

C3.3.1.7.5 Maintenance of distribution system appurtenances (including hydrants and valves).

C3.3.1.7.6 All materials and equipment employed must have the symbol of a recognized control authority (i.e., DIN-DVGW, DVGW, or GS).

C3.3.1.8 Establish an effective cross-connection control and backflow prevention program. Connections to other water supply systems which contain water that is not of drinking water quality are prohibited. Pipes of different water supply systems must be marked with different colors.

C3.3.1.9 Manage underground injection on DoD installations to protect underground water supply sources. At a minimum, conduct monitoring to determine the effects of any underground injection wells on nearby groundwater supplies. Underground injection should not modify the properties of the groundwater.

C3.3.1.10 Develop and update as necessary an emergency contingency plan to ensure the provision of potable water despite interruptions from natural disasters and service interruptions. At a minimum, the plan will include:

C3.3.1.10.1 Identification of key personnel;

C3.3.1.10.2 Procedures to restore service;

C3.3.1.10.3 Procedures to isolate damaged lines;

C3.3.1.10.4 Identification of alternative water supplies;

C3.3.1.10.5 Installation public notification procedures; and

C3.3.1.10.6 Emergency assessment.

C3.3.1.11 Use only lead-free pipe, solder, flux, and fittings in the installation or repair of water systems and plumbing systems for drinking water. Provide installation public notification concerning the lead content of materials used in distribution or plumbing systems, or the corrosivity of water that has caused leaching, which indicates a potential health threat if exposed to leaded water, and remedial actions which may be taken.

C3.3.1.12 Maintain records showing monthly operating reports, bacteriological results, and chemical results for not less than 10 years. On a weekly basis, maintain a record of the additives employed in treating drinking water and their concentrations in the drinking water. Maintain the weekly records for at least 6 months.

C3.3.1.13 Document corrective actions taken to correct breaches of criteria and maintain such records for at least 3 years. Cross connection and backflow prevention testing and repair records should be kept for at least 10 years.

C3.3.1.14 Conduct vulnerability assessments at least once every 5 years.

C3.3.2 TESTING REQUIREMENTS

DoD water systems, regardless of whether they produce or purchase water, will, by independent testing or by validated supplier testing, ensure conformance with the following:

C3.3.2.1 TOTAL COLIFORM BACTERIA REQUIREMENTS

C3.3.2.1.1 An installation responsible for a PWS will conduct a bacteriological monitoring program to ensure the safety of water provided for human consumption and allow evaluation with the total coliform-related MCL. The MCL is based only on the presence or absence of total coliforms. The MCL is no more than 5% positive samples per month for a system examining 40 or more samples a month, and no more than one positive sample per month when a system analyzes less than 40 samples per month. Further, the MCL is exceeded whenever a routine sample is positive for fecal coliforms or *E. coli* or any repeat sample is positive for total coliforms.

C3.3.2.1.2 Each system must develop a written, site-specific monitoring plan and collect routine samples according to Table C3.T2.

C3.3.2.1.3 Table C3.T3 and Table C3.T4 outline standard procedures for microbiological testing. Regulated German water suppliers can be expected to use these procedures. DoD components should use these procedures unless equivalent or more protective procedures are directed by the appropriate DoD medical authorities.

C3.3.2.1.4 Systems with initial samples testing positive for total coliforms will collect repeat samples as soon as possible, preferably the same day, but no later than 24 hours from the original sample collection. Repeat sample locations are required at the same tap as the original sample plus an upstream and a downstream sample, each within five service connections of the original tap. Any additional repeat sampling which may be required will be performed according to the appropriate DoD medical authority. Monitoring will continue until total coliforms are no longer detected.

C3.3.2.1.5 When any routine or repeat sample tests positive for total coliforms, it will be tested for fecal coliform or *E. coli*. Fecal-type testing can be foregone on a total coliform positive sample if fecal or *E. coli* is assumed to be present.

C3.3.2.1.6 If a system has exceeded the MCL for total coliforms, the installation will complete the notification in subsection C3.3.3 to:

C3.3.2.1.6.1 The appropriate DoD medical authority, as soon as possible, but in no case later than the end of the same day the command responsible for operating the PWS is notified of the result.

C3.3.2.1.6.2 The installation public as soon as possible, but not later than 72 hours after the system is notified of the test result that an acute risk to public health may exist.

C3.3.2.2 INORGANIC CHEMICAL REQUIREMENTS

C3.3.2.2.1 An installation responsible for a PWS will ensure that the water distributed to end-users does not exceed applicable limitations set out in Table C3.T5. Except for Nitrate, Nitrite, and Total Nitrate/Nitrite, for systems monitored quarterly or more frequently, a system is out of compliance if the annual running average concentration of an inorganic chemical exceeds the MCL. For systems monitored annually or less frequently, a system is out of compliance if a single sample exceeds the MCL. For Nitrate, Nitrite, and Total Nitrate/Nitrite, system compliance is determined by averaging the single sample that exceeds the MCL with its confirmation sample; if this average exceeds the MCL, the system is out of compliance. Any organic substance not listed in Table C3.T5 that is identified as a hazard to human health shall have its concentration limited to the quantity established by the appropriate DoD medical authority.

C3.3.2.2.2 Systems will be monitored for inorganic chemicals as follows.

C3.3.2.2.2.1 Systems will be monitored for asbestos once every 9 years.

C3.3.2.2.2.2 Systems will be monitored for Nitrate, Nitrite, and Total Nitrate/Nitrite annually except for surface water supplied systems and any groundwater supplied system where testing shows concentrations to be 50 percent or more of the MCL. In these cases, monitoring shall be performed quarterly.

C3.3.2.2.2.3 For all other inorganic substances listed in Table C3.T5, monitoring shall be conducted annually. If an MCL is exceeded, testing for that substance will be conducted on a quarterly basis by obtaining 2 samples per quarter for groundwater supplied systems and at least 4 samples per quarter for surface water supplied systems.

C3.3.2.2.2.4 PWSs shall be analyzed within 1 year of the effective date of these Final Governing Standards to determine the corrosivity of water entering the distribution system. Two samples (one mid-winter and one mid-summer) will be collected at the entry point of the distribution system for systems using surface water and GWUDISW. One sample will be collected for systems using only groundwater. Corrosivity characteristics of the water shall include measurements of the pH, calcium, hardness, alkalinity, temperature, total dissolved solids, and calculation of the Langelier Index.

C3.3.2.2.3 If a system is out of compliance, the installation will complete the notification in subsection C3.3.3 as soon as possible. If the Nitrate, Nitrite, or Total Nitrate and Nitrite MCLs are exceeded, then this is considered an acute health risk and the installation will complete the notification to:

C3.3.2.2.3.1 The appropriate DoD medical authority as soon as possible, but in no case later than the end of the same day the command responsible for operating the PWS is notified of the result.

C3.3.2.2.3.2 The installation public as soon as possible, but not later than 72 hours after the system is notified of the test result. If the installation is only monitoring annually on the basis of direction from the appropriate DoD medical authority, it will immediately increase monitoring in accordance with Table C3.T3, until authorities determine that the system is reliable and consistent and remedial actions completed.

C3.3.2.3 FLUORIDE REQUIREMENTS

C3.3.2.3.1 An installation commander responsible for a PWS will ensure that the fluoride content of drinking water does not exceed the MCL of 1.5 mg/L.

C3.3.2.3.2 Systems will be monitored for fluoride by collecting one treated water sample at the entry point to the distribution system annually for surface water systems and one every 3 years for groundwater systems. Daily monitoring is recommended for systems practicing fluoridation using the criteria in Table C3.T6.

C3.3.2.3.3 If any sample exceeds the MCL, the installation will complete the notification in subsection C3.3.3 as soon as possible, but in no case later than 14 days after the violation.

C3.3.2.4 LEAD AND COPPER REQUIREMENTS

C3.3.2.4.1 DoD CWS and NTNC water systems will comply with action levels (distinguished from the MCL) of 0.015 mg/L for lead and 1.3 mg/L for copper to determine if corrosion control treatment, public education, and removal of lead service lines, if appropriate, are required. Actions are triggered if the respective lead and copper levels are exceeded in more than 10% of all sampled taps (i.e., if the 90^{th} percentile lead and copper levels are greater than 0.015 mg/L and 1.3 mg/L respectively). For water systems serving less than 100 people that collect 5 samples per monitoring period, the "90^{th} percentile" is computed by taking the average of the highest and second highest concentrations. Additionally, the MCL values of 0.04 mg/L for lead and 3 mg/L for copper shall be respected.

C3.3.2.4.2 Affected DoD systems will conduct monitoring in accordance with Table C3.T7. High risk sampling sites will be targeted by conducting a materials evaluation of the distribution system. Sampling sites will be selected as stated in Table C3.T7.

C3.3.2.4.3 If an action level is exceeded, the installation will collect additional water quality samples specified in Table C3.T7. Optimal corrosion control treatment will be pursued. If action levels are exceeded after implementation of applicable corrosion control and source water treatment, lead service lines will be replaced if the lead service lines cause the lead action level to be exceeded. The installation commander will implement an education program for installation personnel (including U.S. and host nation) within 60 days and will complete the notification in subsection C3.3.3 as soon as possible, but in no case later than 14 days after the violation.

C3.3.2.5 SYNTHETIC ORGANICS REQUIREMENTS

C3.3.2.5.1 An installation responsible for CWS and NTNC will ensure that synthetic organic chemicals in water distributed to people do not exceed the limitations delineated in Table C3.T8. For systems monitored quarterly or more frequently, a system is out of compliance if the annual running average concentration of an organic chemical exceeds the MCL. For systems monitored annually or less frequently, a system is out of compliance if a single sample exceeds the MCL.

C3.3.2.5.2 Systems will be monitored for synthetic organic chemicals according to the schedule stated in Table C3.T9.

C3.3.2.5.3 If a system is out of compliance, complete the notification in subsection C3.3.3. as soon as possible, but in no case later than 14 days after the violation. The installation immediately will begin quarterly monitoring and will increase quarterly monitoring if the level of any contaminant is at its detection limit but less than its MCL as noted in Table C3.T8, and will continue until the installation commander determines that the system is back in compliance, and any necessary remedial measures are implemented.

C3.3.2.6 TOTAL TRIHALOMETHANES REQUIREMENTS

C3.3.2.6.1 An installation responsible for a CWS and NTNC system that adds a disinfectant (oxidant, such as chlorine, chlorine dioxide, chloramines, or ozone) to any part of its treatment process (to include the addition of disinfectant by a local water supplier) will ensure that the MCL of 0.01 mg/L for total trihalomethanes is met in drinking water.

C3.3.2.6.2 Such systems that add a disinfectant will monitor total trihalomethanes in accordance with Table C3.T10.

C3.3.2.6.3 If a system is out of compliance, the installation will complete the notification in subsection C3.3.3 as soon as possible, but in no case later than 14 days after the violation, and undertake remedial measures.

C3.3.2.7 RADIONUCLIDE REQUIREMENTS

C3.3.2.7.1 Radioactive substances must not be present in drinking water at concentrations that may be harmful to human health. An installation responsible for a CWS and

NTNC systems will test the system for conformance with the applicable radionuclide limits contained in Table C3.T11.

C3.3.2.7.2 Systems will perform radionuclide monitoring as stated in Table C3.T11.

C3.3.2.7.3 If the average annual MCL for gross alpha activity, total radium (or gross beta in systems serving over 100,000) is exceeded, the installation will complete the notification according to the procedures in subsection C3.3.3 within 14 days. Monitoring will continue until remedial actions are completed and the average annual concentration no longer exceeds the respective MCL. Continued monitoring for gross alpha-related contamination will occur quarterly, while gross beta-related monitoring will be monthly. If any gross beta MCL is exceeded, the major radioactive components will be identified.

C3.3.2.8 SURFACE WATER TREATMENT REQUIREMENTS

DoD water systems employing surface water sources or GWUDISW will meet the surface water treatment requirements delineated in C3.3.1.5 and Table C3.T1.

C3.3.2.9 TURBIDITY REQUIREMENTS

DoD PWS filtered waters will be tested at least once every 4 hours. If the turbidity readings in Table C3.T1 are exceeded, the installation will complete the notification in subsection C3.3.3 as soon as possible, but in no case later than 14 days after the violation, and undertake remedial action.

C3.3.2.9.1 The turbidity of DoD produced water will not exceed 1 Nephelometric Turbidity Units (NTUs). In addition to the monitoring frequency required in Table C3.T1, monitoring for unfiltered and filtered systems is as follows.

- If producing less than 1,000 m^3/year, monitoring must be conducted at least once per year.
- If producing greater than 1,000 m^3/year, monitoring must be conducted once per 15,000 m^3 when disinfecting the water or once per 30,000 m^3 if disinfection is not provided or if the concentration of the disinfecting substance(s) is continuously recorded.

C3.3.2.10 COLOR REQUIREMENTS

The spectral absorption coefficient Hg 436 nm shall not exceed 0.5 m^{-1} using spectrophotometer or filter photometer. Testing shall be conducted once for every 15,000 m^3 of water distributed, but at least annually.

C3.3.2.11 ODOR REQUIREMENTS

The odor threshold value shall not exceed 2 at 12ºC or 3 at 25ºC. Testing shall be conducted once for every 15,000 m^3 of water distributed, but at least annually.

C3.3.2.12 TEMPERATURE REQUIREMENTS

Systems may not deliver water at a temperature higher than 25ºC (plus or minus 1ºC).

C3.3.2.13 HYDROGEN ION CONCENTRATION (PH) REQUIREMENTS

The pH value shall not be less than 6.5 nor greater than 9.5. Systems producing less than 1,000 m^3 must be tested monthly. All other systems must be tested weekly.

C3.3.2.14 CONDUCTIVITY REQUIREMENT

Conductivity shall not exceed 2,000 µS cm^{-1}. Testing shall be conducted for every 15,000 m^3 of water distributed, but at least annually. Single tests are not required if conductivity is recorded continuously.

C3.3.2.15 OXIDIZABILITY REQUIREMENTS

Oxidizability shall not exceed 5 mg/L computed as O_2. Testing shall be conducted for every 15,000 m^3 of water distributed, but at least annually.

C3.3.2.16 TASTE REQUIREMENTS

The taste threshold value shall not exceed 2 at 12ºC or 3 at 25ºC. Testing shall be conducted for every 15,000 m^3 of water distributed, but at least annually.

C3.3.2.17 DISSOLVED OR EMULSIFIED HYDROCARBONS REQUIREMENTS

The MCL for dissolved or emulsified hydrocarbons (mineral oils) is 0.01 mg/L. Testing is only required at the request of the corresponding authorities.

C3.3.2.18 SUBSTANCES EXTRACTABLE WITH CHLOROFORM REQUIREMENTS

The MCL for substances extractable with chloroform is 1 mg/L. Testing is only required at the request of the corresponding authorities.

C3.3.2.19 SURFACTANT REQUIREMENTS

The MCL for surfactants (methylene blue, anionic, and nonionic substances) is 0.2 mg/L. Testing is only required at the request of the corresponding authorities.

C3.3.2.20 NON-PUBLIC WATER SYSTEMS

DoD NPWSs will be monitored as a minimum for total coliforms and disinfectant residuals periodically.

C3.3.2.21 ALTERNATIVE WATER SUPPLIES

DoD installations will, if necessary, only utilize alternative water sources, including POE/POU treatment devices and bottled water supplies, which are approved by the Installation Commander.

C3.3.3 NOTIFICATION REQUIREMENTS

C3.3.3.1 When a DoD water system is out of compliance as set forth in subparagraphs C3.3.2.1 through C3.3.2.9, the appropriate DoD medical authority and installation personnel (U.S. and host nation) will be notified. The notice will provide a clear and readily understandable explanation of the violation, any potential adverse health effects, the population at risk, the steps that the system is taking to correct the violation, the necessity for seeking alternative water supply, if any, and any preventive measures the consumer should take until the violation is corrected. The appropriate DoD medical authority will coordinate notification of host nation authorities in cases where off-installation populations are at risk.

C3.3.3.2 When a DoD water system is out of compliance as set forth in subparagraphs C3.3.2.10 through C3.3.2.16, the Installation Commander, in consultation with the appropriate DoD medical authority, will determine if notification of installation personnel (U.S. and host nation) is necessary.

C3.3.4 SYSTEM OPERATOR REQUIREMENTS

DoD installations will ensure that personnel are appropriately trained to operate DoD water systems.

C3.3.5 PERMISSIONS

C3.3.5.1 DoD installations that produce drinking water from groundwater sources must obtain permission from the regional authorities to withdraw groundwater.

C3.3.5.2 The permitting and construction of wells, wellheads, piping, retention basins, and treatment plants are addressed by state construction laws and technical standards (i.e., DIN, DVGW). As part of the issuance of construction permits, operating requirements are established and included in an operating permit. If a permit has been issued for DoD operated facilities, the requirements contained in the permit must be complied with. If the permit requires a more protective standard that prescribed in these FGS, the standard in the permit shall be the compliance standard; however, if the permit allows a less protective standard, then the FGS will be the compliance standard unless a waiver is obtained.

Table C3.T1 Surface Water Treatment Requirements

1. Unfiltered Systems

   a. Systems which use unfiltered surface water or groundwater sources under the direct influence of surface water will analyze the raw water for total coliforms or fecal coliforms at least weekly and for turbidity at least daily for a minimum of one year. If the total coliforms and/or fecal coliforms exceed 100/100 mL and 20/100 mL, respectively, appropriate filtration must be applied. Appropriate filtration must also be applied if turbidity exceeds 1 Nephelometric Turbidity Unit (NTU).

   b. Disinfection must achieve at least 99.9% (3-log) inactivation of *Giardia lamblia* cysts and 99.99% (4-log) inactivation of viruses by meeting applicable CT values, as shown in Tables C3.T10. through C3.T23.

   c. Disinfection systems must have redundant components to ensure uninterrupted disinfection during operational periods.

   d. Disinfectant residual monitoring immediately after disinfection is required once every 4 hours that the system is in operation. Disinfectant residual measurements in the distribution system will be made weekly.

   e. Disinfectant residual of water entering the distribution system must be maintained between a minimum of 0.2 mg/L and a maximum of 4.0 mg/L.

   f. Water in a distribution system with a heterotrophic bacteria concentration less than or equal to 500/mL measured as heterotrophic plate count is considered to have a detectable disinfectant residual for the purpose of determining compliance with the Surface Water Treatment Requirements.

   g. If disinfectant residuals in the distribution system are undetected in more than 5% of monthly samples for 2 consecutive months, appropriate filtration must be implemented.

2. Filtered Systems

   a. Filtered water systems will provide a combination of disinfection and filtration that achieves a total of 99.9% (3-log) removal of *Giardia lamblia* cysts and 99.99% (4-log) removal of viruses.

   b. The turbidity of filtered water will be monitored at least once every 4 hours. (USACHPPM/USAEC). The turbidity of filtered water will not exceed 0.5 NTU (1 NTU for slow sand and diatomaceous earth filters) in 95% of the analyses in a month, with a maximum of 5 NTU.

   c. Disinfection must provide the remaining log-removal of *Giardia lamblia* cysts and viruses not obtained by the filtration technology applied.*

   d. Disinfection residual maintenance and monitoring requirements are the same as those for unfiltered systems.

*Proper conventional treatment typically removes 2.5 log Giardia/ 2.0 log viruses. Proper direct filtration and diatomaceous earth filtration remove 2.0 log Giardia/ 1.0 log viruses. Slow sand filtration typically removes 2.0 log Giardia/ 2.0 log viruses. Less log-removal may be assumed if treatment is not properly applied.

Table C3.T2 Total Coliform Monitoring Frequency

Population Served	Number of Samples [1]	Population Served	Number of Samples [1]
25 to 1,000 [2]	1	59,001 to 70,000	70
1,001 to 2,500	2	70,001 to 83,000	80
2,501 to 3,300	3	83,001 to 96,000	90
3,301 to 4,100	4	96,001 to 130,000	100
4,101 to 4,900	5	130,001 to 220,000	120
4,901 to 5,800	6	220,001 to 320,000	150
5,801 to 6,700	7	320,001 to 450,000	180
6,701 to 7,600	8	450,001 to 600,000	210
7,601 to 8,500	9	600,001 to 780,000	240
8,501 to 12,900	10	780,001 to 970,000	270
12,901 to 17,200	15	970,001 to 1,230,000	300
17,201 to 21,500	20	1,230,001 to 1,520,000	330
21,501 to 25,000	25	1,520,001 to 1,850,000	360
25,001 to 33,000	30	1,850,001 to 2,270,000	390
33,001 to 41,000	40	2,270,001 to 3,020,000	420
41,001 to 50,000	50	3,020,001 to 3,960,000	450
50,001 to 59,000	60	3,960,001 or more	480

Notes

1. Minimum Number of Routine Samples Per Month
2. A non-community water system using groundwater and serving 1,000 or less people may monitor once in each calendar quarter during which the system provides water, provided a sanitary survey conducted within the last 5 years shows the system is supplied solely by a protected groundwater source and free of sanitary defects.

   Systems that serve less than 4,900 people that use groundwater and that collect samples from different sites may collect all samples on a single day. All other systems must collect samples at regular intervals throughout the month.

Table C3.T3 Approved Analytical Test Methods

Parameter	Methodology	Analytical Method Code[1]
Color	Colorimetry (436 nm)	DIN 38 404-C1 (EN ISO 7887)
Turbidity	Turbidimetric method (Nepheleometry) Formazine Turbidity Units FTU= NTU	DIN 38 404-C2 (DIN EN ISO 7027)
Odor	Technique with progressive dilutions at 25 °C and 12°C (Olfactometry)	DEV B1 /2
Taste	Technique with progressive dilutions at 25 °C and 12°C	Oral description
Temperature	Thermometry	DIN 38 404-C4
Hydrogen ion concentration (pH-value at … °C)	Electrometry with glass electrode pH-value after $CaCo_3$-saturation at ...°C	DIN 38 404-C5 DIN 38 404-C10
Electric conductivity at 25°C µS/cm	Electrometry	DIN 38 404-C8 (DIN EN 27 888)
Chlorides	Volumetric test (Mohr method) Mercurimetric method with indicator Ion chromatography	DIN 38 405-D1 Don't use (toxic reagent) DIN 38405-D19 (DIN EN ISO 11885)
Sulfates	Turbidimetric method Gravimetry Complexometry with EDTA Ion chromatography	No DIN standard method DIN 38 405-D5 DIN 38 405-D5 DIN 38405-D19 (DIN EN ISO 10304-1)
Silica	ICP-OES (silicon determiation) Photometric analysis of solved Silicia and silicate	DIN 38 406-E22 DIN 38405-D21
Calcium	ICP-OES Complexometry	DIN 38 406-E22 DIN 38406-E3-3 (DIN EN ISO 11885)
Magnesium	ICP-OES Complexometry	DIN 38 406-E22 DIN 38406-E3-3 (DIN EN ISO 11885)
Sodium	ICP-OES Flame photometry Atomic absorption spectrometry Ion-specific electrode	DIN 38 406-E22 DIN 38 406-E27 DIN 38 406-E14 (DIN EN ISO 11885)
Potassium	ICP-OES Flame photometry Atomic absorption spectrometry Ion-specific electrode	DIN 38 406-E22 DIN 38 406-E27 DIN 38 406-E13 (DIN EN ISO 11885)
Aluminum	ICP-OES	DIN 38 406-E22 (DIN EN ISO 11885)
Total hardness	Total of Calcium and Magnesium	

Parameter	Methodology	Analytical Method Code[1]
Dry residues	Drying at 180 °C To avoid confusion: There is also the parameter dried matter with drying temperature 105 °C	DIN38 409-H1
Dissolved Oxygen	Winkler method Electrometrical method (Clark sensor)	DIN 38 408-G21, EN 25813 DIN 38 408-G22, EN 25814
Dissolved CO_2	Acidimetry (calculated through acid binding capacity and base binding capacity and pH-value) Gassensitive electrode	DIN 38 409-H7
NO_3	Ion chromatography Ion specific electrode	DIN 38405-D19
NO_2	Ion chromatography	DIN 38405-D19
NH_4	Colourimetry (Berthelots reaction) Volumetric test upon distillation Ion-specific electrode	DIN 38 406-E5
Kjeldahl nitrogen	Decomposition with Selenium (only for N till oxidation number –3, organic N will be detected incomplete) Usual practiced: Total bound nitrogen TN_b Catalytic reduction (700 °C)	EN 25663; (ISO 5663) DIN 38 409-H28
Oxidizability	Potassium permanganate method	DIN 38 409-H5
Total organic carbonium	Instrumental method	DIN 38 409-H3
H_2S	Photometric method	DIN 38 406-D26
Chloroform extractable substances	Calculated as residue of evaporation Not practiced in Germany, this parameter is fulfilled, if TVO's limit value for oxidizability is not exceeded	No German standard
Dissolved or emulsified Hydrocarbons; mineral oils	Infrared spectrophotometry upon extraction with 1,1,2-Trichlorotrifluoroethane and elimination of polar compounds with Aluminumoxide Gravimetry upon extraction with petroleum ether	DIN 38 407-H18
Phenols	Phenol-Index with distillation Phenol-Index total	DIN 38 407-H16-2 DIN 38 407-H16-1
Boron	ICP-OES	DIN 38 406-E22 (DIN EN ISO 11885)
Anionic surfactants	Photometric method, calculated as methyleneblueactive substance (MBAS)	DIN 38 409-H23
Non-ionic surfactants	Potentiometric method, calculated as bismuth-active substance (BiAS)	DIN 38 409-H23
Organo-halogenated compounds (whithout pesticides)	1,1,1-Trichloroethane, Trichloroethene, Tetrachloroethene, Dichloromethane, carbon tetrachloride Gas chromatography with head space on column injection	DIN 38 407 Teil 5

Parameter	Methodology	Analytical Method Code[1]
Iron	Colourimetric and photometric method ICP-OES	DIN 38 406-E1 DIN 38 406-E22 (DIN EN ISO 11885)
Manganese	Photometric method ICP-OES	DIN 38 406-E2 DIN 38 406-E22 (DIN EN ISO 11885)
Copper	Polarography Atomic absorption spectrometry ICP-OES	DIN 38 406-E16 DIN 38 406-E21 DIN 38 406-E22 (DIN EN ISO 11885)
Zinc	Polarography Atomic absorption spectrometry ICP-OES	DIN 38 406-E16 DIN 38 406-E21 DIN 38 406-E22 (DIN EN ISO 11885)
Total Phosphorus	Photometric method with chemical digestion Peroxidisulfate, 30 minutes, 100°C	DIN 38 405-D11 (DIN EN 1189)
Fluoride	Ion chromatography Ion specific electrode	DIN 38 405-D19 DIN 38 405-D4
Cobalt	Polarography Atomic absorption spectrometry ICP-OES	DIN 38 406-E16 DIN 38 406-E21 DIN 38 406-E22
Suspended materials	Filtration on ashless paper or membrane with negative pressure	DIN 38 409-H1
Residual chlorine	Volumetric test (Mohr method) Mercurimetric method with indicator Ion chromatography Potentiometry	DIN 38 405-D1 Don't use (toxic reagent) DIN 38405-D19
Barium	ICP-OES	DIN 38406-E22 (DIN EN ISO 11885)
Silver	ICP-OES Atomic absorption Spectrometry	DIN 38406-E22 DIN 38 406-E21 (DIN EN ISO 11885)
Arsenic	ICP-OES	DIN 38406-E22 (DIN EN ISO 11885)
Berillium	ICP-OES	DIN 38406-E22
Cadmium	Polarography Atomic absorption spectrometry ICP-OES	DIN 38 406-E16 DIN 38 406-E21 DIN 38 406-E22 (DIN EN ISO 11885)

Parameter	Methodology	Analytical Method Code[1]
Cyanide	Photometric method	DIN 38 405-D13
Chromium	ICP-OES	DIN 38 406-E22 (DIN EN ISO 11885)
Mercury	Atomic absorption spectrometry, Hydrid- method on cold stream	DIN 38 406 Teil 12 (DIN EN 1483)
Nickel	Polarography Atomic absorption spectrometry ICP-OES	DIN 38 406-E16 DIN 38 406-E21 DIN 38 406-E22 (DIN ENISO 11885)
Lead	Polarography Atomic absorption spectrometry ICP-OES	DIN 38 406-E16 DIN 38 406-E21 DIN 38 406-E22 (DIN EN ISO 11885)
Antimony	ICP-OES	DIN 38406-E22 (DIN EN ISO 11885)
Selenium	ICP-OES	DIN 38406-E22 (DIN EN ISO 11885)
Vanadium	ICP-OES	DIN 38406-E22
Pesticides	Gas or liquid chromatography upon extraction through solvents and purification If needed: transform to derivatives Possible added equipment: MS, PID, ECD, FID Identification of the mixture components and quantitative determination.	DIN 38 407-F6 (for nitrogen and phosphorus containing pesticides) (DIN V 38407 Teil 6) DIN 38407-F11 (selected list of pesticides, AMD-method) DIN 38407-F12 (selected list of pesticides, HPLC analysis) DIN 38 407-F14 (for Phenyl alkyl carbon acids, GC-MS method) DIN 38-407-F2 (for aldrin, dieldrin, endrin, and isodrin)
Polycyclic aromatic hydrocarbons (PAH)	Extraction with Cyclohexane, thin layer chromatography for 6 reference PAH compounds HPLC EPA standard is practiced in Germany	DIN 38 409-H13 DIN 38 409-F8 EPA 610
PCB/Ts	-	DIN 38 414 part 20
Total coliforms	MPN method MF method EPA Methods: - Presence Absence with bromocresol purple - (MMO-MUG)-Colilert - Colisure	TVO Appendix 1, para. 2, a TVO Appendix 1, para. 2, b

Parameter	Methodology	Analytical Method Code[1]
E. coli	MPN method MF method EPA Methods: - Presence Absence with bromocresol purple - (MMO-MUG)-Colilert - Colisure	TVO Appendix 1, para. 1, a TVO Appendix 1, para. 1, b
Fecal coliforms Not in TVO	MPN method MF method EPA Methods: - Presence Absence with bromocresol purple - (MMO-MUG)-Colilert - Colisure	
Fecal streptococcus	Manufacturing culture media MPN method MF method	ISO 7899 TVO Appendix1, para 3, a TVO Appendix, para 3, b
Clostrides sulfite - reducing spore	 MPN method MF method	EN 26 461-K7 TVO Appendix1, para 4, a TVO Appendix 1, para 4, b
Agar colonies calculation		
Colony count	Defined as colony number is the number of colonies visible under six to eight fold magnification which form from the bacteria, found in 1 ml of the water to be examined, in plate cultures with nutritious, peptone-containing culture media (1 percent meat extract, 1 percent peptone) at an incubation temperature of 20°C +/-2°C and 36°C +/-1°C after an incubation time of 44 +/-4 hours.	DIN 38 411-K5 (MF-method) TVO Appendix 1, para. 5

Notes

1. In the future, the German DIN standards will be replaced by a general European standard. At this time, this process is currently underway. Some of the DIN standards are just being transferred into European standards and will therefore only receive a new name with the abbreviation DIN EN. Others will be replaced completely as a different methodology will be adopted. The third group are the DIN V standards which are being prepared for the transformation into a European standard. The methodologies in the table which already have a DIN EN or at least a DIN V standards show this standard in brackets.

Table C3.T4 Descriptions of Approved Microbiological Testing Procedures

1. Escherichia coli

The test for Escherichia coli in at least 100 mL of water is performed by:

a. liquid enrichment with maximum triple-strength lactose broth (in a final concentration of 1 percent lactose); or

b. membrane filtration whereby the filter is placed in 50 mL of 1 percent lactose broth.

The incubation temperature is always 36°C +/- 1°C and the incubation time at least 24 +/-4 hours; if negative, up to 44 +/-4 hours.

If the lactose broth shows the "formation of gas and acid", the detection shall be quantified to allow the assessment of the extent of contamination by E.coli. A final diagnosis is not possible with the metabolic characteristic "formation of gas and acid" from lactose at 36°C +/-1°C alone so that, in addition, at least the following metabolic characteristics must be determined after subculture or pure culture on endo-agar (lactose-fuchsine-sulphite-agar) or McConkey or an equivalent culture medium for a period of 24 +/-4 hours at 36°C +/-1°C:

a. oxidase reaction (Nadi): negative;

b. formation of indole from tryptophane-containing broth: positive;

c. splitting-up of dextrose or mannitol in 1%-broth at 44°C +/-1°C within 24 +/-4 hours under formation of gas and acid;

d. exhaustion of citrate as sole carbon source: negative.

2. Coliform Germs

The test for coliform germs in at least 100 mL of water is performed by:

a. liquid enrichment with adequately concentrated, yet maximum triple-strength lactose broth (in a final concentration of 1 percent lactose); or

b. membrane filtration whereby the filter is placed in 50 mL of 1 percent lactose broth.

The incubation temperature is always 36°C +/-1°C, the incubation time at least 24 +/-4 hours; if negative, up to 44 +/-4 hours.

If the lactose broth shows the "formation of gas and acid", the detection shall be quantified to allow the assessment of the extent of contamination by coliform germs. A final diagnosis is not possible with the metabolic characteristic "formation of gas and acid" from lactose at 36° +/-1°C alone so that, in addition, at least the following metabolic characteristics must be determined after subculture or pure culture on endo-agar (lactose-fuchsine-sulphite-agar) or Mc Conkey or an equivalent culture medium for a period of 24 +/- 4 hours at 36°C +/-1°C:

a. oxidase reaction (Nadi): negative;

b. splitting-up of lactose, under formation of gas and acid, in 1%-broth at 36oC +/- 1oC within 44 +/- 4 hours;

c. formation of indole from tryptophane-containing broth: negative (positive reaction possible);

d. exhaustion of citrate as a sole carbon source: positive (negative reaction possible).

3. Fecal streptococci

The test for fecal streptococci in at least 100 mL of water is performed by:

a. liquid enrichment with adequately concentrated, yet maximum triple-strength azide-dextrose broth (with a sodium azide-final concentration of 0.02 to 0.05 percent and a dextrose final concentration of 0.5 to 1 percent); or

b. membrane filtration whereby the filter is placed in 50 mL of single-concentrated azide-dextrose broth (in a sodium azide-concentration of 0.02 to 0.05 percent).

The incubation temperature is always 36°C +/-1°C and the incubation time at least 24 +/-4 hours; if negative, up to 44 +/-4 hours.

The final diagnosis is not possible by way of the growth in azide-dextrose broth (clouding or pH-change) so that at least the following characteristics must be fulfilled in addition.

a. Culture on kanamycin-aesculin-azide or tetrazolium-azide-agar (e.g., Slanetz-Bartley-Agar).

b. The incubation temperature is always 36°C +/-1°C, the incubation time at least 24 +/-4 hours; in case of tetrazolium-azide-agar, up to 44 +/-4 hours.

c. Colonies of typical growth shall be stained by Gram's method; gram-positive diplococci are regarded as fecal streptococci.

4. Sulphite-Reducing Sporulating Anaerobes

The test for sulphite-reducing sporulating anaerobes (clostridia) in at least 20 mL water is performed, after heating the sample to 75°C +/-5°C for a period of 10 minutes, by way of:

a. liquid enrichment with double-strength dextrose-iron citrate-sodium sulphite broth (DRCM-broth), incubation temperature 36°C +/- 1°C, incubation period 24 +/- 4 hours, observation for another 24 +/- 4 hours; or

b. membrane filtration whereby the membrane filter is placed in dextrose-iron citrate-sodium sulphite broth (DRCM-broth), incubation temperature 36°C +/- 1°C, incubation period 24 +/- 4 hours, observation for another 24 +/- 4 hours.

A final diagnosis is not possible by way of the growth in broth (blackening) so that, in addition, at least the following metabolic characteristics must be given:

a. Inoculation to blood-glucose-agar, incubation temperature 36°C +/- 1°C, incubation period 24 +/- 4 hours anaerobic; and

b. In case of growth, examination by means of aerobic subculture under the same conditions.

5. Colony Count Determination.

Defined as colony number is the number of colonies visible under six to eight fold magnification which form from the bacteria, found in 1 mL of the water to be examined, in plate cultures with nutritious, peptone-containing culture media (1 percent meat extract, 1 percent peptone) at an incubation temperature of 20°C +/-2°C and 36°C +/-1°C after an incubation time of 44 +/-4 hours.

The usable culture media differ primarily in the setting agent so that the following methods are possible:

a. agar-gelatin culture media, incubation temperature 20°C +/-2°C and 36°C +/-1°C, incubation time 44 +/-4 hours; or

b. agar-culture media, incubation temperature 20°C +/-2°C and 36°C +/-1°C, incubation time 44 +/-4 hours.

Table C3.T5 Inorganic Chemical MCLs

Contaminant	MCL
Aluminum [1]	0.2 mg/L
Ammonium (NH_4) [1]	0.5 mg/L
Antimony [1]	0.006 mg/L
Arsenic	0.01 mg/L
Asbestos [2]	7 million fibers/L
Barium	1.0 mg/L
Beryllium	0.004 mg/L
Boron [1]	1 mg/L
Cadmium	0.005 mg/L
Calcium [1]	400 mg/L
Chloride [1]	250 mg/L
Chromium	0.05 mg/L
Copper	1.3 mg/L
Cyanide	0.05 mg/L
Fluoride	1.5 mg/L
Free Available Chlorine (FAC)	*4.0 mg/L*
Iron [1]	0.2 mg/L
Kjeldahl Nitrogen [1]	1 mg/L
Lead	0.04 mg/L
Magnesium [1]	50 mg/L
Manganese [1]	0.05 mg/L
Mercury	0.001 mg/L
Nickel	0.05 mg/L
Nitrate (as N) [3]	10 mg/L
Nitrite (as N)	0.03 mg/L
Total Nitrite and Nitrate (as N) [4]	10 mg/L
Phosphorus (as PO_4) [1]	6.7 mg/L as PO_4^-
Potassium [1]	12 mg/L
Selenium	0.01 mg/L
Silver	0.01 mg/L
Sodium	150 mg/L
Sulfate (as SO_4) [1]	240 mg/L as SO_4
Surfactants (anionic and non-ionic)	0.2 mg/L
Thallium	0.002 mg/L
Zinc	5 mg/L

Notes:

1. Sample for these chemicals only upon direction of the medical authority. When sampled, these MCLs apply.
2. Applies to CWS and NTNC systems.
3. Applies to CWS, NTNC, and TNC systems. For all other systems the MCL is 50.
4. Applies to CWS, NTNC, and TNC systems only.

Samples shall be taken as follows: Groundwater systems shall take a minimum of one sample at every entry point to the distribution system, which is representative of each well after treatment; surface water systems shall take at least one sample at every point to the distribution system after any application of treatment or in the distribution system at a point which is representative of each source after the treatment.

Table C3.T6 Recommended Fluoride Concentrations at Different Temperatures

Annual Average of Maximum Daily Air Temperatures (°F)	Control Limits (mg/L)		
	Lower	Optimum	Upper
50.0 - 53.7	0.9	1.2	1.5
53.8 - 58.3	0.8	1.1	1.5
58.4 - 63.8	0.8	1.0	1.3
63.9 - 70.6	0.7	0.9	1.2
70.7 - 79.2	0.7	0.8	1.0
79.3 - 90.5	0.6	0.7	0.8

Table C3.T7 Monitoring Requirements for Lead and Copper Water Quality Parameters

Population Served	No. of Sites for Standard Monitoring [1, 2]	No. of Sites for Reduced Monitoring [3]	No. of Sites for Water Quality Parameters [4]
>100,000	100	50	25
10,001 - 100,000	60	30	10
3,301 - 10,000	40	20	3
501 - 3,300	20	10	2
101 - 500	10	5	1
<100	5	5	1

Notes

1. Every 6 months for lead and copper.
2. Sampling sites shall be based on a hierarchical approach. For CWS, priority will be given to single family residences that contain copper pipe with lead solder installed after 1982; contain lead pipes; or are served by lead service lines; then, structures, including multifamily residences, with the foregoing characteristics; and finally, residences and structures with copper pipe with lead solder installed before 1983. For NTNC systems, sampling sites will consist of structures that contain copper pipe with lead solder installed after 1982; contain lead pipes; and/or are served by lead service lines. First draw samples will be collected from a cold water kitchen or bathroom tap; non-residential samples will be taken at an interior tap from which water is typically drawn for consumption.
3. Annually for lead and copper if action levels are met during each of two consecutive 6 month monitoring periods. Any small or medium-sized system (<50,000) that meets the lead and copper action levels during 3 consecutive years may reduce the monitoring for lead and copper from annually to once every 3 years. Annual or triennial sampling will be conducted during the 4 warmest months of the year.
4. This monitoring must be conducted by all large systems (>50,000). Small and medium sized systems must monitor water quality parameters when action levels are exceeded. Samples will be representative of water quality throughout the distribution system and include a sample from the entry to the distribution system. Samples will be taken in duplicate for pH, alkalinity, calcium, conductivity or total dissolved solids, and water temperatures to allow a corrosivity determination (via a Langelier saturation index or other appropriate saturation index); additional parameters are orthophosphate when a phosphate inhibitor is used and silica when a silicate inhibitor is used.

Table C3.T8 Synthetic Organic Compound MCLs

Synthetic Organic Compound	MCL (mg/L)
Pesticides/PCBs	
Pesticide substances considered separately. For example: - Alachlor - Aldicarb - Aldicarb Sulfone - Aldiccarb sulfoxide - Atrazine - Carbofuran - Chlordane - 2,4-D - 1,2-Dibromo-3-chloropropane (DBCP) - Endrin - Ethylene dibromide (EDB) - Heptachlor - Lindane - Methoxychlor	0.0001
Total Pesticides	0.0005
Polychlorinated, polybrominated biphenyls and terphenyls considered separately[1]	0.0001
Total polychlorinated, polybrominated biphenyls and terphenyls [1]	0.0005
Polycyclic Aromatic Hydrocarbons (PAHs)	
Polycyclic Aromatic Hydrocarbons (total of): - Fluoranthene - Benzo-(b)-Fluoranthene - Benzo-(k)-Fluoranthene - Benzo-(a)-Pyrene - Benzo-(ghi)-Perylene - Indeno (1,2,3,-cd)-Pyrene	0.0002 (total)
Volatile Organic Compounds	
Benzene	0.005
Carbon tetrachloride	0.003
o-Dichlorobenzene	0.6
cis-1,2-Dichloroethylene	0.07
trans-1,2-Dichloroethylene	0.1
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane[2]	0.01
1,2-Dichloroethane	0.005
Dichloromethane[2]	0.01
1,1,2-Tricholoroethane	0.005
1,2,4-Trichloro-benzene	0.07
1,2-Dichloropropane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1
para-Dichlorobenzene	0.075

Synthetic Organic Compound	MCL (mg/L)
Styrene	0.1
Tetrachloroethylene[2]	0.005
Trichloroethylene[2]	0.005
Toluene	1
Vinyl chloride	0.002
Xylene (total)	10
Other Organics	
Acrylamide	Treatment technique[3]
Epihydrochlorin	Treatment technique[3]
Organic chlorinated compounds - 1,1,1 Trichloroethane - Trichloroethane - Tetrachloroethene - Dichloro methane	0.01 (total)
Phenol	0.0005[4]
Total Petroleum Hydrocarbons	0.01[4]

Notes:

1. Polybrominated biphenyls, and polychlorinated/polybrominated terphenyls will be sampled upon direction of competent medical authority.
2. Combined total may not exceed 0.01 mg/L.
3. Best available treatment technique relates polymer addition practices.
4. Sample only when directed by the appropriate DoD medical authorities.

Table C3.T9 Synthetic Organic Chemical Monitoring Requirements

Contaminant	Base Requirement [1]		Trigger for more monitoring [6]	Reduced monitoring
	Groundwater	Surface water		
VOCs	Quarterly	Quarterly	>0.0005 mg/L	Yes [2, 3]
Pesticides/PCB/Ts	4 quarterly samples/3 years during most likely period for their presence		>Detection limit [5]	Yes [3, 4]
PAHs	Annually for < 1,000,000 m^3/yr Biannually for > 1,000,000 m^3/yr		>0.0002 mg/L	No

Notes

1. Groundwater systems shall take a minimum of one sample at every entry point which is representative of each well after treatment; surface water systems will take a minimum of one sample at every entry point to the distribution system at a point which is representative of each source after treatment. For CWS, monitoring compliance is to be met within 1 year of the publishing of the OEBGD (FGS); for NTNC, compliance is to be met within 2 years of the publishing of the OEBGD (FGS).
2. Repeat sampling frequency may be reduced to annually after 1 year of no detection and every 3 years after three rounds of no detection.
3. Monitoring frequency may be reduced if warranted based on a vulnerability assessment by the PWS.
4. Repeat sampling frequency may be reduced to the following if after one round of no detection: systems >3,300 reduce to two samples/year every 3 years, or systems <3,300 reduce to one sample every 3 years.
5. Detection limits noted in Table C3.T8, or as determined by the best available testing methodology.
6. Increased monitoring requires a minimum of two samples per quarter for groundwater systems and at least four samples per quarter for surface water systems.

Note: Compliance is based on an annual running average for each sample point for systems monitoring quarterly or more frequently; for systems monitoring annually or less frequently, compliance is based on a single sample, unless the appropriate DoD medical authority requests a confirmation sample. A system is out of compliance if any contaminant exceeds the MCL.

Table C3.T10 Total Trihalomethane Monitoring Requirements

Population Served by System	Number of Samples Per Distribution System	Frequency of Samples	Type of Sample
10,000 or more	4	Quarterly	Treated
Less than 10,000	1	Annually	Treated

Notes

1. One of the samples must be taken at a location in the distribution system reflecting the maximum residence time of water in the system. The remaining samples shall be taken at representative points in the distribution system. Systems using groundwater sources that add a disinfectant should have one sample analyzed for maximum total trihalomethane potential. Systems employing surface water sources, in whole or in part, that add a disinfectant should have one sample analyzed for total trihalomethanes.
2. Compliance is based upon a running yearly average of quarterly samples for systems serving more than 10,000 people. Noncompliance exists if the average exceeds the MCL, 0.10 mg/L. For systems serving less than 10,000 which have a maximum total trihalomethane potential sample exceeding the MCL, a sample for total trihalomethanes shall be analyzed. If the total trihalomethane sample exceeds the MCL, noncompliance results.

Table C3.T11 Radionuclide MCLs and Monitoring Requirements

Radionuclide	pCi/L
Gross Alpha [1]	15
Combined Radium-226 and –228	5
Gross Beta [2]	50

Notes

1. Gross alpha activity includes radium-226, but excludes radon and uranium.
2. Monitoring for gross beta is only required for surface water systems over 100,000. Gross beta activity refers to the sum of beta particle and photon activity from manmade radionuclides. If gross beta exceed the MCL, i.e., equivalence to a dose of 4 millirem/year, the individual components must be determined (Strontium-90 and Tritium). See 40 CFR 141.26(b) (reference (g)) for additional information.

Monitoring Requirements

For gross alpha activity and radium-226 and radium-228, systems will be tested once every 4 years. Testing will be conducted using an annual composite of four consecutive quarterly samples or the average of four samples obtained at quarterly intervals at a representative point in the distribution system.

Gross alpha only may be analyzed if activity is ≤5 pCi/L. Where radium-228 may be present, radium-226 and/or -228 analyses should be performed when activity is >2 pCi/L. If the average annual concentration is less than half the maximum contaminant level, analysis of a single sample may be substituted for the quarterly sampling procedure. A system with two or more sources having different concentrations of radioactivity shall monitor source water in addition to water from a free-flowing tap. If the installation introduces a new water source, these contaminants will be monitored within the first year after introduction.

Table C3.T12 CT Values for Inactivation of *Giardia* Cysts by Free Chlorine at 0.5°C or Lower*

Chlorine Concentration (mg/L)	pH< = 6 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations						pH = 7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	23	46	69	91	114	137	27	54	82	109	136	163	33	65	98	130	163	195	40	79	119	158	198	237
0.6	24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200	40	80	120	159	199	239
0.8	24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205	41	82	123	164	205	246
1	25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210	42	84	127	169	211	253
1.2	25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215	43	86	130	173	216	259
1.4	26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221	44	89	133	177	222	266
1.6	26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	151	188	226	46	91	137	182	228	273
1.8	27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231	47	93	140	186	233	279
2	28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236	48	95	143	191	238	286
2.2	28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242	50	99	149	198	248	297
2.4	29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247	50	99	149	199	248	298
2.6	29	58	88	117	146	175	35	70	105	139	174	209	42	84	126	168	210	252	51	101	152	203	253	304
2.8	30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257	52	103	155	207	258	310
3	30	60	91	121	151	181	36	72	109	145	181	217	44	87	131	174	218	261	53	105	158	211	263	316

Chlorine Concentration (mg/L)	pH< = 8 Log Inactivations						pH = 8.5 Log Inactivations						pH = 9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	46	92	139	185	231	277	55	110	165	219	274	329	65	130	195	260	325	390
0.6	48	95	143	191	238	286	57	114	171	228	285	342	68	136	204	271	339	407
0.8	49	98	148	197	246	295	59	118	177	236	295	354	70	141	211	281	352	422
1	51	101	152	203	253	304	61	122	183	243	304	365	73	146	219	291	364	437
1.2	52	104	157	209	261	313	63	125	188	251	313	376	75	150	226	301	376	451
1.4	54	107	161	214	268	321	65	129	194	258	323	387	77	155	232	309	387	464
1.6	55	110	165	219	274	329	66	132	199	265	331	397	80	159	239	318	398	477
1.8	56	113	169	225	282	338	68	136	204	271	339	407	82	163	245	326	408	489
2	58	115	173	231	288	346	70	139	209	278	348	417	83	167	250	333	417	500
2.2	59	118	177	235	294	353	71	142	213	284	355	426	85	170	256	341	426	511
2.4	60	120	181	241	301	361	73	145	218	290	363	435	87	174	261	348	435	522
2.6	61	123	184	245	307	368	74	148	222	296	370	444	89	178	267	355	444	533
2.8	63	125	188	250	313	375	75	151	226	301	377	452	91	181	272	362	453	543
3	64	127	191	255	318	382	77	153	230	307	383	460	92	184	276	368	460	552

*$CT_{99.9}$ =CT for 3 log inactivation.

Table C3.T13 CT Values for Inactivation of *Giardia* Cysts by Free Chlorine at 5.0°C*

Chlorine Concentration (mg/L)	pH< = 6 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations						pH = 7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	16	32	49	65	81	97	20	39	59	78	98	117	23	46	70	93	116	139	28	55	83	111	138	166
0.6	17	33	50	67	83	100	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	114	143	171
0.8	17	34	52	69	86	103	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175
1	18	35	53	70	88	105	21	42	63	83	104	125	25	50	75	99	124	149	30	60	90	119	149	179
1.2	18	36	54	71	89	107	21	42	64	85	106	127	25	51	76	101	127	152	31	61	92	122	153	183
1.4	18	36	55	73	91	109	22	43	65	87	108	130	26	52	78	103	129	155	31	62	94	125	156	187
1.6	19	37	56	74	93	111	22	44	66	88	110	132	26	53	79	105	132	158	32	64	96	128	160	192
1.8	19	38	57	76	95	114	23	45	68	90	113	135	27	54	81	108	135	162	33	65	98	131	163	196
2	19	39	58	77	97	116	23	46	69	92	115	138	28	55	83	110	138	165	33	67	100	133	167	200
2.2	20	39	59	79	98	118	23	47	70	93	117	140	28	56	85	113	141	169	34	68	102	136	170	204
2.4	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	115	143	172	35	70	105	139	174	209
2.6	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175	36	71	107	142	178	213
2.8	21	41	62	83	103	124	25	49	74	99	123	148	30	59	89	119	148	178	36	72	109	145	181	217
3	21	42	63	84	105	126	25	50	76	101	126	151	30	61	91	121	152	182	37	74	111	147	184	221

Chlorine Concentration (mg/L)	pH< = 8 Log Inactivations						pH = 8.5 Log Inactivations						pH = 9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	33	66	99	132	165	198	39	79	118	157	197	236	47	93	140	186	233	279
0.6	34	68	102	136	170	204	41	81	122	163	203	244	49	97	146	194	243	291
0.8	35	70	105	140	175	210	42	84	126	168	210	252	50	100	151	201	251	301
1	36	72	108	144	180	216	43	87	130	173	217	260	52	104	156	208	260	312
1.2	37	74	111	147	184	221	45	89	134	178	223	267	53	107	160	213	267	320
1.4	38	76	114	151	189	227	46	91	137	183	228	274	55	110	165	219	274	329
1.6	39	77	116	155	193	232	47	94	141	187	234	281	56	112	169	225	281	337
1.8	40	79	119	159	198	238	48	96	144	191	239	287	58	115	173	230	288	345
2	41	81	122	162	203	243	49	98	147	196	245	294	59	118	177	235	294	353
2.2	41	83	124	165	207	248	50	100	150	200	250	300	60	120	181	241	301	361
2.4	42	84	127	169	211	253	51	102	153	204	255	306	61	123	184	245	307	368
2.6	43	86	129	172	215	258	52	104	156	208	260	312	63	125	188	250	313	375
2.8	44	88	132	175	219	263	53	106	159	212	265	318	64	127	191	255	318	382
3	45	89	134	179	223	268	54	108	162	216	270	324	65	130	195	259	324	389

*$CT_{99.9}$ =CT for 3 log inactivation.

Table C3.T14 CT Values for Inactivation of *Giardia* Cysts by Free Chlorine at 10°C*

Chlorine Concentration (mg/L)	pH< = 6 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations						pH = 7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	12	24	37	49	61	73	15	29	44	59	73	88	17	35	52	69	87	104	21	42	63	83	104	125
0.6	13	25	38	50	63	75	15	30	45	60	75	90	18	36	54	71	89	107	21	43	64	85	107	128
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112	22	45	67	89	112	134
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114	23	46	69	91	114	137
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116	23	47	70	93	117	140
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	96	120	144
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122	25	49	74	98	123	147
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124	25	50	75	100	125	150
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127	26	51	77	102	128	153
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129	26	52	79	105	131	157
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131	27	53	80	107	133	160
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134	27	54	82	109	136	163
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137	28	55	83	111	138	166

Chlorine Concentration (mg/L)	pH< = 8 Log Inactivations						pH = 8.5 Log Inactivations						pH = 9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	25	50	75	99	124	149	30	59	89	118	148	177	35	70	105	139	174	209
0.6	26	51	77	102	128	153	31	61	92	122	153	183	36	73	109	145	182	218
0.8	26	53	79	105	132	158	32	63	95	126	158	189	38	75	113	151	188	226
1	27	54	81	108	135	162	33	65	98	130	163	195	39	78	117	156	195	234
1.2	28	55	83	111	138	166	33	67	100	133	167	200	40	80	120	160	200	240
1.4	28	57	85	113	142	170	34	69	103	137	172	206	41	82	124	165	206	247
1.6	29	58	87	116	145	174	35	70	106	141	176	211	42	84	127	169	211	253
1.8	30	60	90	119	149	179	36	72	108	143	179	215	43	86	130	173	216	259
2	30	61	91	121	152	182	37	74	111	147	184	221	44	88	133	177	221	265
2.2	31	62	93	124	155	186	38	75	113	150	188	225	45	90	136	181	226	271
2.4	32	63	95	127	158	190	38	77	115	153	192	230	46	92	138	184	230	276
2.6	32	65	97	129	162	194	39	78	117	156	195	234	47	94	141	187	234	281
2.8	33	66	99	131	164	197	40	80	120	159	199	239	48	96	144	191	239	287
3	34	67	101	134	168	201	41	81	122	162	203	243	49	97	146	195	243	292

*$CT_{99.9}$ =CT for 3 log inactivation.

Table C3.T15 CT Values for Inactivation of *Giardia* Cysts by Free Chlorine at 15°C*

Chlorine Concentration (mg/L)	pH< = 6 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations						pH = 7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	89	107
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111

Chlorine Concentration (mg/L)	pH< = 8 Log Inactivations						pH = 8.5 Log Inactivations						pH = 9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	17	33	50	66	83	99	20	39	59	79	98	118	23	47	70	93	117	140
0.6	17	34	51	68	85	102	20	41	61	81	102	122	24	49	73	97	122	146
0.8	18	35	53	70	88	105	21	42	63	84	105	126	25	50	76	101	126	151
1	18	36	54	72	90	108	22	43	65	87	108	130	26	52	78	104	130	156
1.2	19	37	56	74	93	111	22	45	67	89	112	134	27	53	80	107	133	160
1.4	19	38	57	76	95	114	23	46	69	91	114	137	28	55	83	110	138	165
1.6	19	39	58	77	97	116	24	47	71	94	118	141	28	56	85	113	141	169
1.8	20	40	60	79	99	119	24	48	72	96	120	144	29	58	87	115	144	173
2	20	41	61	81	102	122	25	49	74	98	123	147	30	59	89	118	148	177
2.2	21	41	62	83	103	124	25	50	75	100	125	150	30	60	91	121	151	181
2.4	21	42	64	85	106	127	26	51	77	102	128	153	31	61	92	123	153	184
2.6	22	43	65	86	108	129	26	52	78	104	130	156	31	63	94	125	157	188
2.8	22	44	66	88	110	132	27	53	80	106	133	159	32	64	96	127	159	191
3	22	45	67	89	112	134	27	54	81	108	135	162	33	65	98	130	163	195

*$CT_{99.9}$ =CT for 3 log inac tivation.

Table C3.T16 CT Values for Inactivation of *Giardia* Cysts by Free Chlorine at 20°C*

Chlorine Concentration (mg/L)	pH< = 6 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations						pH = 7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	6	12	18	24	30	36	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62
0.6	6	13	19	25	32	38	8	15	23	30	38	45	9	18	27	36	45	54	11	21	32	43	53	64
0.8	7	13	20	26	33	39	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66
1	7	13	20	26	33	39	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67
1.2	7	13	20	27	33	40	8	16	24	32	40	48	10	19	29	38	48	57	12	23	35	46	58	69
1.4	7	14	21	27	34	41	8	16	25	33	41	49	10	19	29	39	48	58	12	23	35	47	58	70
1.6	7	14	21	28	35	42	8	17	25	33	42	50	10	20	30	39	49	59	12	24	36	48	60	72
1.8	7	14	22	29	36	43	9	17	26	34	43	51	10	20	31	41	51	61	12	25	37	49	62	74
2	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62	13	25	38	50	63	75
2.2	7	15	22	29	37	44	9	18	27	35	44	53	11	21	32	42	53	63	13	26	39	51	64	77
2.4	8	15	23	30	38	45	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
2.6	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66	13	27	40	53	67	80
2.8	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67	14	27	41	54	68	81
3	8	16	24	31	39	47	10	19	29	38	48	57	11	23	34	45	57	68	14	28	42	55	69	83

Chlorine Concentration (mg/L)	pH< = 8 Log Inactivations						pH = 8.5 Log Inactivations						pH = 9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	12	25	37	49	62	74	15	30	45	59	74	89	18	35	53	70	88	105
0.6	13	26	39	51	64	77	15	31	46	61	77	92	18	36	55	73	91	109
0.8	13	26	40	53	66	79	16	32	48	63	79	95	19	38	57	75	94	113
1	14	27	41	54	68	81	16	33	49	65	82	98	20	39	59	78	98	117
1.2	14	28	42	55	69	83	17	33	50	67	83	100	20	40	60	80	100	120
1.4	14	28	43	57	71	85	17	34	52	69	86	103	21	41	62	82	103	123
1.6	15	29	44	58	73	87	18	35	53	70	88	105	21	42	63	84	105	126
1.8	15	30	45	59	74	89	18	36	54	72	90	108	22	43	65	86	108	129
2	15	30	46	61	76	91	18	37	55	73	92	110	22	44	66	88	110	132
2.2	16	31	47	62	78	93	19	38	57	75	94	113	23	45	68	90	113	135
2.4	16	32	48	63	79	95	19	38	58	77	96	115	23	46	69	92	115	138
2.6	16	32	49	65	81	97	20	39	59	78	98	117	24	47	71	94	118	141
2.8	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	95	119	143
3	17	34	51	67	84	101	20	41	61	81	102	122	24	49	73	97	122	146

*$CT_{99.9}$ =CT for 3 log inactivation.

Table C3.T17 CT Values for Inactivation of *Giardia* Cysts by Free Chlorine at 25°C*

Chlorine Concentration (mg/L)	pH< = 6 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations						pH = 7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	4	8	12	16	20	24	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	28	35	42
0.6	4	8	13	17	21	25	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43
0.8	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44
1	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45
1.2	5	9	14	18	23	27	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46
1.4	5	9	14	18	23	27	6	11	17	22	28	33	7	13	20	26	33	39	8	16	24	31	39	47
1.6	5	9	14	19	23	28	6	11	17	22	28	33	7	13	20	27	33	40	8	16	24	32	40	48
1.8	5	10	15	19	24	29	6	11	17	23	28	34	7	14	21	27	34	41	8	16	25	33	41	49
2	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	27	34	41	8	17	25	33	42	50
2.2	5	10	15	20	25	30	6	12	18	23	29	35	7	14	21	28	35	42	9	17	26	34	43	51
2.4	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43	9	17	26	35	43	52
2.6	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44	9	18	27	35	44	53
2.8	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45	9	18	27	36	45	54
3	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46	9	18	28	37	46	55

Chlorine Concentration (mg/L)	pH< = 8 Log Inactivations						pH = 8.5 Log Inactivations						pH = 9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	8	17	25	33	42	50	10	20	30	39	49	59	12	23	35	47	58	70
0.6	9	17	26	34	43	51	10	20	31	41	51	61	12	24	37	49	61	73
0.8	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75
1	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
1.2	9	18	28	37	46	55	11	22	34	45	56	67	13	27	40	53	67	80
1.4	10	19	29	38	48	57	12	23	35	46	58	69	14	27	41	55	68	82
1.6	10	19	29	39	48	58	12	23	35	47	58	70	14	28	42	56	70	84
1.8	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
2	10	20	31	41	51	61	12	25	37	49	62	74	15	29	44	59	73	88
2.2	10	21	31	41	52	62	13	25	38	50	63	75	15	30	45	60	75	90
2.4	11	21	32	42	53	63	13	26	39	51	64	77	15	31	46	61	77	92
2.6	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
2.8	11	22	33	44	55	66	13	27	40	53	67	80	16	32	48	64	80	96
3	11	22	34	45	56	67	14	27	41	54	68	81	16	32	49	65	81	97

*$CT_{99.9}$ =CT for 3 log inactivation.

Table C3.T18 CT Values for Inactivation of Viruses by Free Chlorine

	Log Inactivation		Log Inactivation		Log Inactivation	
	2.0 pH		3.0 pH		3.0 pH	
Temperature (C)	6-9	10	6-9	10	6-9	10
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	3	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

Table C3.T19 CT Values for Inactivation of Giardia Cysts by Chlorine Dioxide

	Temperature (C)					
Inactivation	<=1	5	10	15	20	25
0.5-log	10	4.3	4	3.2	2.5	2
1-log	21	8.7	7.7	6.3	5	3.7
1.5-log	32	13	12	10	7.5	5.5
2-log	42	17	15	13	10	7.3
2.5-log	52	22	19	16	13	9
3-log	63	26	23	19	15	11

Table C3.T20 CT Values for Inactivation of Viruses by Free Chlorine Dioxide pH 6-9

	Temperature (C)					
Removal	<=1	5	10	15	20	25
2-log	8.4	5.6	4.2	2.8	2.1	1.4
3-log	25.6	17.1	12.8	8.6	6.4	4.3
4-log	50.1	33.4	25.1	16.7	12.5	8.4

Table C3.T21 CT Values for Inactivation of Giardia Cysts by Ozone

	Temperature (C)					
Inactivation	<=1	5	10	15	20	25
0.5-log	0.48	0.32	0.23	0.16	0.12	0.08
1-log	0.97	0.63	0.48	0.32	0.24	0.16
1.5-log	1.5	0.95	0.72	0.48	0.36	0.24
2-log	1.9	1.3	0.95	0.63	0.48	0.32
2.5-log	2.4	1.6	1.2	0.79	0.60	0.40
3-log	2.9	1.9	1.43	0.95	0.72	0.48

Table C3.T22 CT Values for Inactivation of Viruses by Free Ozone

	Temperature (C)					
Inactivation	**<=1**	**5**	**10**	**15**	**20**	**25**
2-log	0.9	0.6	0.5	0.3	0.25	0.15
3-log	1.4	0.9	0.8	0.5	0.4	0.25
4-log	1.8	1.2	1.0	0.6	0.5	0.3

Table C3.T23 CT Values for Inactivation of Giardia Cysts by Chloramine pH 6-9

	Temperature (C)					
Inactivation	**<=1**	**5**	**10**	**15**	**20**	**25**
0.5-log	635	365	310	250	185	125
1-log	1,270	735	615	500	370	250
1.5-log	1,900	1,100	930	750	550	375
2-log	2,535	1,470	1,230	1,000	735	500
2.5-log	3,170	1,830	1,540	1,250	915	625
3-log	3,800	2,200	1,850	1,500	1,100	750

Table C3.T24 CT Values for Inactivation of Viruses by Chloramine

	Temperature (C)					
Inactivation	**<=1**	**5**	**10**	**15**	**20**	**25**
2-log	1,243	857	643	428	321	214
3-log	2,063	1,423	1,067	712	534	356
4-log	2,883	1,988	1,491	994	746	497

Table C3.T25 CT Values for Inactivation of Viruses by UV

Log Inactivation	
2.0	**3.0**
21	36