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Chapter NR 810

REQUIREMENTS FOR THE OPERATION AND MAINTENANCE OF PUBLIC WATER SYSTEMS

NR 810.01 Applicability.
NR 810.015 Alternative requirements.
NR 810.02 Definitions.

Subchapter I — General Operations
NR 810.03 General operational requirements.
NR 810.04 Certified operator requirement.
NR 810.05 Required sampling and testing.
NR 810.06 Operational sampling.
NR 810.07 Operational reporting.
NR 810.08 Drinking water standards.
NR 810.09 General treatment and disinfection requirements.
NR 810.10 Distribution system normal pressure.
NR 810.11 Distribution system fire flow pressure.
NR 810.12 Distribution system loss of pressure.
NR 810.13 System maintenance.
NR 810.14 Water storage facility inspections.
NR 810.15 Cross connections and interconnections.
NR 810.16 Local well regulation program.
NR 810.17 Temporary water supply and pressure.
NR 810.18 System loss and unaccounted water.
NR 810.19 Discharge of system or backwash water.
NR 810.20 Approval of operational changes or maintenance projects.
NR 810.21 Unattended water treatment plant operation.
NR 810.22 Emergency well operation.
NR 810.23 Water system security and emergency operations.
NR 810.24 Water system capacity.
NR 810.25 Operation and maintenance manuals.
NR 810.26 Other requirements.

Subchapter II — Surface Water Treatment and Groundwater Under the Direct Influence of Surface Water Treatment Operations
NR 810.27 General requirements for all surface water and groundwater under the direct influence of surface water systems.
NR 810.28 Requirements for covers on water storage structures.
NR 810.29 Basic filtration requirements.
NR 810.295 Filter backwash handling.
NR 810.30 Criteria for avoiding filtration for groundwater under the direct influence of surface water systems.
NR 810.31 Disinfection requirements for Giardia lamblia and viruses.
NR 810.32 Disinfection profiling and benchmarking.
NR 810.33 Enhanced treatment requirements for Cryptosporidium.
NR 810.34 Cryptosporidium bin classification for filtered systems.
NR 810.35 Cryptosporidium treatment requirements for filtered systems.
NR 810.36 Cryptosporidium treatment requirements for groundwater under the direct influence of surface water systems that do not filter.
NR 810.37 Cryptosporidium treatment requirement compliance schedule.
NR 810.38 Monitoring requirements.
NR 810.39 Reporting requirements.
NR 810.40 Recordkeeping requirements.

Subchapter III — Toolbox Options for Meeting Enhanced Treatment for Cryptosporidium Requirements
NR 810.41 Microbial toolbox options.
NR 810.42 Source toolbox components.
NR 810.43 Pre−filtration treatment toolbox components.
NR 810.44 Treatment performance toolbox components.
NR 810.45 Additional filtration toolbox components.

Subchapter IV — Inactivation Toolbox Components and CT Tables
NR 810.46 Inactivation toolbox components.
NR 810.47 CT table for giardia when using free chlorine at 0.5°C or lower.
NR 810.48 CT table for giardia when using free chlorine at 5°C.
NR 810.49 CT table for giardia when using free chlorine at 10°C.
NR 810.50 CT table for giardia when using free chlorine at 15°C.
NR 810.51 CT table for giardia when using free chlorine at 20°C.
NR 810.52 CT table for giardia when using free chlorine at 25°C.
NR 810.53 CT table for viruses when using free chlorine.
NR 810.54 CT table for Giardia lamblia when using chlorine dioxide.
NR 810.55 CT table for viruses when using chlorine dioxide.
NR 810.56 CT table for Cryptosporidium when using chlorine dioxide.
NR 810.57 CT table for Giardia lamblia when using chloramines.
NR 810.58 CT table for viruses when using chloramines.
NR 810.59 CT table for Giardia lamblia when using ozone.
NR 810.60 CT table for viruses when using ozone.
NR 810.61 CT table for Cryptosporidium when using ozone.
NR 810.62 UV dose table for Cryptosporidium, Giardia lamblia, and viruses.

NR 810.01 Applicability. This chapter governs the general operation and maintenance of all public water systems, unless noted otherwise within each section. This chapter shall apply to each public water system, unless the public water system meets all of the following conditions:

(1) Consists only of distribution and storage facilities, and does not have any collection or treatment facilities.

(2) Obtains all of its water from, but is not owned or operated by, a public water system to which such regulations apply.

(3) Does not sell water to any person.

(4) Is not a carrier which conveys passengers in interstate commerce.

Note: The authority to promulgate and enforce these rules is contained in chs. 280 and 281, Stats. Pursuant to s. 299.97, Stats., any person who violates this chapter shall forfeit not less than $10 nor more than $5,000 for each violation. Each day of continued violation is a separate offense.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.015 Alternative requirements. (1) If the owner of a water system determines that compliance with the operation and maintenance requirements of this chapter is impracticable, the owner may submit in writing to the department a request to use alternative criteria. This request shall contain the reasons that compliance with the operation and maintenance criteria is impracticable and alternative criteria for which department approval is sought and all pertinent facts, data, reports and studies supporting the proposed alternative.

(2) If the department determines that compliance with the operation and maintenance requirements of this chapter would be impracticable in any specific case, or that an alternative proposed has additional benefits with adequate safeguards, it may approve alternative criteria which are in substantial compliance with the requirements of this chapter.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.02 Definitions. In this chapter:

(1) "A.N.S.I." means the American National Standards Institute.

Note: The ANSI address is 25 West 43rd St, New York, NY 10036.

(2) "A.P.I." means the American Petroleum Institute.

Note: The API address is 1220 L Street NW, Washington, DC 20005−4070.

(3) "Approval" means the written approval of the department for any project requiring approval pursuant to s. 281.41, Stats., and s. NR 108.03 for community systems, and s. NR 812.09 for non−community systems.

(4) "ASTM" or "ASTM International" means the organization formerly known as the American Society for Testing and Material.

Note: The ASTM or ASTM International address is 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania 19148−2959.

(5) "A.W.W.A." means the American Water Works Association.

Note: The AWWA address is 6666 West Quincy Avenue, Denver, Colorado 80235.

(6) "Community water system" means a public water system which serves at least 15 service connections used by year−round residents or regularly serves at least 25 year−round residents. Any water system serving 7 or more homes, 10 or more mobile homes, 10 or more apartment units, 10 or more duplex units, or 10 or more condominium units shall be considered a community water system unless information is provided by the owners indicating that 25 year−round residents will not be served.

(7) "Consecutive system" means a public water system that receives some or all of its finished water from one or more wholesale suppliers or wholesaler systems through a master metering system. This system may also be known as a wholesale purchaser or wholesale customer. Delivery may be through a direct connection or through the distribution system of one or more consecutive systems.

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

(9) "Cross connection" means a connection or potential connection between any part of a water supply system and another environment containing substances in a manner that, under any circumstances, would allow the substances to enter the water supply system by means of back siphonage or back pressure.

(10) "CT" or "CT calc" is the product of the residual disinfectant concentration (C) in mg/l determined before or at the first customer, and the corresponding disinfectant contact time (T) in minutes, for example, "C" x "T". If a public water system applies disinfectants at more than one point prior to the first customer, the water supplier shall determine the CT of each disinfectant sequence before or at the first customer, to determine the total percent inactivation or "total inactivation ratio." The inactivation ratio for a single disinfectant sequence is:

$$\frac{CT_{calc}}{CT_{table}}$$

where "CT_{table}" is the CT value required for the target organism and the target level of inactivation as contained in ss. NR 810.47 to 810.61. The sum of the inactivation ratios, or total inactivation ratio for a series of disinfection sequences is:

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

and is calculated by adding together the inactivation ratio for each disinfection sequence. In determining the total inactivation ratio, the water supplier shall determine the residual disinfectant concentration of each sequence and corresponding contact time before any subsequent disinfection application points. A total inactivation ratio equal to or greater than 1.0 is assumed to provide the target level of disinfection of the target organism.

(11) "Department" means the department of natural resources.

(12) "Diatomaceous earth filtration" means a process resulting in substantial particulate removal in which all of the following occurs:

(a) A precoat cake of diatomaceous earth filter media is deposited on a support membrane or septum.

(b) 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.

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

(14) "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.

(a) 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 where residual disinfectant concentration ("C") is measured.

(b) Where more than one "C" is measured, "T" is determined as follows:

1. For the first measurement of "C", "T" is 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.

2. For subsequent measurements of "C", "T" is 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.

(c) Disinfectant contact time in pipelines shall be calculated based on "plug flow" by dividing the internal volume of the pipe by the maximum hourly flow rate through the pipe.

(d) Disinfectant contact time within mixing basins and storage reservoirs shall be determined by tracer studies or other department approved equivalent demonstration.

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

(16) "Disinfection profile" means a summary of daily *Giardia lamblia* inactivation through the treatment plant. The procedure for developing a disinfection profile is contained in s. NR 810.32.

(17) "Displacement zone" means the 3−dimensional subsurface region surrounding an aquifer storage recovery well into which treated drinking water is placed for storage and later recovery.

(18) "Distribution system" means all pipes or conduits by which water is delivered to consumers except piping and fixtures inside buildings served, water services and private water mains as defined in ch. SPS 381.

(19) "Entry point" means a location in the water system after treatment or chemical addition, if any, but prior to the distribution system.

(20) "Filtered system" means a public water system that is required to use filtration to meet the basic filtration requirements of s. NR 810.29.

(21) "Filter profile" means a graphical representation of individual filter performance, based on continuous turbidity measurements or total particle counts versus time for an entire filter run, from startup to backwash inclusively, that includes an assessment of filter performance while another filter is being backwashed.

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

(23) "Groundwater" means any of the waters of the state, as defined in s. 281.01 (18), Stats., occurring in a saturated subsurface geological formation of rock or soil.

(24) "Groundwater source" means all groundwater obtained from horizontal collectors, infiltration lines, springs, and dug, drilled or other types of wells.

(25) "Groundwater under the direct influence of surface water" or "GWUDI" means any water beneath the surface of the ground with either:

(a) Occurrence of insects or other macroorganisms, algae or large diameter pathogens such as *Giardia lamblia* or *Cryptosporidium,* in greater than or equal to 10% of representative source water samples collected over a period of 6 months, immediately prior to the first or only point of disinfectant application.

(b) Evidence of relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions where the department determines that these shifts are indications of the potential for contamination of the groundwater by the organisms identified in par. (a).

(26) "Living unit" means a residence, apartment unit, condominium unit, duplex unit, manufactured home or other domicile.

(27) "Membrane filtration" means a pressure or vacuum driven separation process in which particulate matter larger than one micrometer is rejected by an engineered barrier, primarily through a size−exclusion mechanism, and which has a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test. This definition includes the common membrane technologies of microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.

(28) "Municipal water system" means a community water system owned by a city, village, county, town, town sanitary district, utility district, public inland lake and rehabilitation district, municipal water district or a federal, state, county or municipal owned institution for congregate care or correction, or a privately owned water utility serving the foregoing.

(29) "Non−community water system" means a public water system that is not a community water system. A non−community water system may be either a non−transient non−community water system or a transient non−community water system.

(30) "Non−transient non−community water system" or "NTNCWS" means a non−community water system that regularly serves at least 25 of the same persons over 6 months per year.

Note: Examples of non−transient non−community water systems include those serving schools, day care centers and factories.

(31) "NSF" or "NSF International" means the organization formerly known as the National Sanitation Foundation.

Note: The NSF or NSF International address is PO Box 130140, 789 N. Dixboro Road, Ann Arbor, Michigan 48113−0140.

(32) "Operator−in−charge" means the person designated by the owner of the waterworks to be in direct responsible charge of a subclass of operations of the waterworks. Not included in this definition are utility managers, city engineers, directors of public works or the equivalent, who are not actually involved in day−to−day operations.

(33) "Other−than−municipal water system" or "OTM" means a community water system that is not a municipal water system.

(34) "Person" means an individual, corporation, company, association, cooperative, trust, institution, partnership, state, municipality, or federal agency.

(35) "Public water system" or "system" or "PWS" means a system for the provision to the public of piped water for human consumption through pipes or other constructed conveyances, if the system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. A public water system is either a "community water system" or a "non−community water system". A system:

(a) Includes any collection, treatment, storage and distribution facilities under the control of the operator of a system and used primarily in connection with the system.

(b) Includes any collection or pretreatment storage facilities not under the system's control which are used primarily in connection with the system.

Note: The definition of public water system as regulated by this chapter is broader and includes more water systems than those governed by the public service commission under its definition of a public utility in ch. 196, Stats.

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

(37) "Reviewable project" has the same meaning as in s. NR 108.02 (13).

(38) "SCADA" means Supervisory Control and Data Acquisition, a computer system used for gathering and analyzing real time data used to monitor and control water systems and their components.

(39) "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.

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

(41) "Surface water systems" means public water systems using surface water or groundwater under the direct influence of surface water as a source and that are subject to the requirements of 40 CFR 141, subpart H, P, and W, which contains the national primary drinking water regulations.

(42) "Transient non−community water system" or "TNCWS" means a non−community water system that serves at least 25 people at least 60 days of the year but does not regularly serve at least 25 of the same persons over 6 months per year.

Note: Examples of transient non−community water systems include those serving taverns, motels, restaurants, churches, campgrounds and parks.

(43) "Unfiltered system" means a public water system using groundwater under the direct influence of surface water that is not a filtered system.

(44) "Utility" means a public utility as defined in ch. 196, Stats.

(45) "UV" means ultraviolet light.

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

(47) "Water storage facilities" means vented reservoirs, water towers, standpipes and treatment plant basins including ground and elevated storage structures. It does not include hydropneumatic tanks or natural surface water bodies.

(48) "Water supplier" means any person who owns or operates a public water system.

(49) "Waterworks" or "water system" means all facilities, structures, pipes, conduits and appurtenances by means of which water is delivered to consumers except piping and fixtures inside buildings served, water services and private water mains as defined in ch. SPS 381.

(50) "Well" means an excavation or opening into the ground made by digging, boring, drilling, driving or other methods for the purpose of obtaining groundwater.

(51) "Well driller" means a person defined as a well driller by s. 280.01 (2m), Stats.

(52) "Wholesale" or "wholesaler system" means a public water system that treats source water as necessary to produce finished water and then delivers some or all of that finished water to another public water system through one or more master meters. Delivery may be through a direct connection or through the distribution system of one or more consecutive systems.

(53) "WPDES permit" means the Wisconsin pollutant discharge elimination system permit issued by the department under ch. 283, Stats., for the discharge of pollutants.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10; correction in (51) made under s. 13.92 (4) (b) 7., Stats., Register November 2010 No. 659; **correction in (18) and (49) made under s. 13.92 (4) (b) 7., Stats., Register January 2012 No. 673.**

Subchapter I — General Operations

NR 810.03 General operational requirements. The water supplier shall be responsible for ensuring that the public water system is operated and maintained to provide an adequate quantity of safe drinking water to those consumers served by the supplier. This responsibility includes maintaining or contracting for an adequate number of trained staff to perform all duties necessary, performing maintenance and replacement of equipment when necessary to keep the facilities in good operating condition, and providing adequate laboratory testing equipment to control and monitor treatment processes and chemical addition programs. All water suppliers for community systems shall operate the public water system within the design parameters of ch. NR 811 and all parameters of the specific plan approvals for that system. This responsibility also includes ensuring that sufficient fiscal resources are available for adequate operation and maintenance.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.04 Certified operator requirement. The water supplier shall provide certified operators as follows:

(1) Municipal water systems shall provide a certified operator as required by s. NR 108.06 (2). Operators shall meet the certification requirements of ss. NR 114.04, 114.12 (2), and 114.13.

(2) Other−than−municipal water systems operators shall meet the requirements of ss. NR 114.30 to 114.32.

(3) Non−transient non−community water systems operators shall meet the requirements of ss. NR 114.30 to 114.32.

(4) Transient non−community water systems are exempted from certified operator requirements.

(5) The department shall be notified within 30 days when the water supplier has employed a new operator−in−charge for each

subclass. The operator's name, contact information, and certification number shall be sent to the department after being hired.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.05 Required sampling and testing. The water supplier shall be responsible for sampling, testing and reporting treatment plant and distribution system water quality information to the department, in accordance with the applicable requirements of this chapter and chs. NR 108, 140, 149, 809, and 811. The department may require the installation of sample hydrants if sufficient, representative sample locations are not reasonably accessible in the distribution system.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.06 Operational sampling. Sampling and testing, in addition to the required sampling and testing required in s. NR 810.05, shall be performed by the water supplier as required by the department in writing. The department may require additional sampling and testing when necessary to verify water quantity and quality, treatment plant effectiveness, adequate distribution system operation, and to protect water consumers.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.07 Operational reporting. (1) Water suppliers for the following public water systems shall submit monthly reports in a form or format as required by the department to the appropriate regional office of the department:

(a) All municipal water systems.

(b) Other−than−municipal water systems which have chemical or physical treatment.

(c) Any public water system with a pumping capacity of 70 gpm or more.

(d) Any other public water system as required by the department.

(2) Reports shall include all the following data, if applicable:

(a) Daily quantities of water pumped.

(b) Daily quantities of chemicals added to the water.

(c) Daily operation of treatment processes.

(d) Results of chemical, physical, or other tests performed for plant control.

(e) Calculated theoretical daily residuals and residual test results.

(f) Groundwater depth measurements, static and pumping, at least weekly where applicable.

(g) Totals and averages of the above where spaces are provided on the report form.

(h) Other data determined necessary by the department.

(3) For other−than−municipal and non−community water systems, the frequency of pumpage and chemical treatment data collection may be reduced by approval of the department in writing, but for those water systems with chemical treatment, in no case shall it be less than twice per week. Reduced frequency shall only be considered in cases where treatment is not required to meet primary drinking water standards for coliform bacteria, fecal coliform, *Cryptosporidium, Giardia lamblia*, viruses, nitrate, nitrite, chlorate, or chlorite.

(4) Computer generated forms developed by the water supplier are acceptable if, at a minimum, all the required data are submitted on the form, and if the form of the report receives the approval of the department prior to use. Electronic submittal of the reporting forms shall be allowed if done in a form and format approved by the department.

(5) Monthly reports for municipal water systems shall be signed by the operator−in−charge or an operator certified in the applicable treatment process employed by the water supplier. At other−than−municipal and non−transient non−community water systems, reports shall be signed by the small system certified operator.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.08 Drinking water standards. Where practical, the quality of the raw water source shall meet the primary maximum contaminant levels of ch. NR 809 and other applicable requirements of ch. NR 809 and this chapter without treatment. In all cases, the quality of finished water supplied to consumers by public water systems shall meet the primary drinking water standards contained in ch. NR 809.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.09 General treatment and disinfection requirements. Department approved treatment shall be provided and operated by each water supplier where necessary in order to ensure that the finished water supplied to consumers meets the primary maximum contaminant levels contained in ch. NR 809 and the design standards contained in ch. NR 811, where applicable. In addition, all of the following requirements shall be met:

(1) CHEMICAL TREATMENT. (a) All existing and new municipal water systems and all other−than−municipal water systems constructed or modified after December 1, 2010, shall be provided with equipment and the necessary appurtenances which can continuously disinfect the water. The department may require the installation of disinfection equipment at existing other−than−municipal water systems where deemed necessary to ensure a safe water supply. Standby disinfection equipment shall be periodically checked and repaired, if necessary, to ensure it will work when it is required.

(b) All surface water treatment plants and other waterworks where treatment is required to produce a water quality meeting the primary maximum contaminant levels shall be equipped with backup chemical feed equipment for all chemicals required for treatment in the event of failure of the primary equipment.

(c) Written approval from the department is required prior to the addition of any chemical to a community water system. Non−community water systems shall refer to s. NR 812.37 for plan approval requirements for chemical feed systems. At public water systems that treat continuously, a 30−day supply of chemicals shall be kept on hand as required by s. NR 108.06 (3). The 30−day supply shall be based on average day demand and average dose. Chemicals shall meet current A.W.W.A. standards and be approved by the department. Department approval may consist of, but is not limited to, certification of the chemical for use in potable water under NSF/ANSI Standard 60. Those chemical suppliers relabeling or repackaging NSF/ANSI 60 certified chemicals shall also be certified. Laboratories evaluating products for compliance with NSF/ANSI Standard 60 shall be certified by the American National Standards Institute. Colored chemicals shall be approved if coloring agents are not used in toxic concentrations or in amounts which impart taste, odor or color to the water supply. The department may require the analysis of chemicals if necessary to insure use of safe chemicals.

Note: Copies of these standards are available for inspection at the office of the Department of Natural Resources and the Legislative Reference Bureau.

Note: The Department of Safety and Professional Services requires plan submittal and approval of all treatment systems installed to service non−community water systems and designed to reduce health−related contaminants. For more information, see s. SPS 382.20.

(d) Chemical containers shall be labeled to include the chemical name, purity, concentration, and name and address of the chemical supplier.

(e) Requests for the substitution of disinfection agents in lieu of chlorine for bacteriological control shall be submitted to the department for review. Substitute disinfection agents may not be used without specific approval by the department.

(f) Solution tanks shall be maintained in a sanitary condition.

(g) The department may require an assay of chemicals delivered.

(h) A material safety data sheet (MSDS) shall be obtained by the water supplier from the chemical supplier for every chemical.

(2) DISINFECTION OF WATER FROM GROUNDWATER SOURCES. (a) All municipal water systems shall provide continuous disinfection of the water prior to entry to the distribution system within 36 months of December 1, 2010. For systems that provide disin-

File inserted into Admin. Code 2−1−2012. May not be current beginning 1 month after insert date. For current adm. code see:
http://docs.legis.wisconsin.gov/code/admin_code

fection by chlorination, chloramination, or chlorine dioxide, a detectable residual shall be provided throughout the distribution system.

Note: It is recommended that all community water systems provide a detectable disinfectant residual throughout the distribution system.(b) When disinfection of water drawn from a groundwater source is required in order to meet the MCL for total coliform or E. coli contained in ch. NR 809 to maintain bacteriologically safe water, the residual maintained in the distribution system and the residual monitoring shall be as required in ss. NR 809.74 (2) and NR 811.43 (2). Additional disinfection requirements including disinfectant contact time or compliance with the disinfection requirements of s. NR 810.31 (1) may be required by the department on a case−by−case basis. The following conditions, as well as other conditions, are considered by the department to be existing or potential water system public health threats:

1. A public water system history of microbiological contamination in the water source or distribution system by either coliform or noncoliform bacteria.
2. The presence of color in raw water from a well serving a public water system.
3. Inadequate construction, including construction which does not meet current requirements of ch. NR 811 or 812, of a well which serves a public water system.

(3) DISINFECTION OF WATER FROM SURFACE WATER AND GROUNDWATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER SOURCES. (a) For free chlorine, the concentration in the water entering the distribution system of any public water system, primary or consecutive, served by treated surface water shall be at least 0.2 mg/l at the entry point to the distribution system and detectable throughout the distribution system. For total combined chlorine, the concentration in the water entering the distribution system of any public water system served by treated surface water shall be at least 1.0 mg/l at the entry point to the distribution system and detectable throughout the distribution system. Residual monitoring of the water entering the distribution system shall be provided as required in s. NR 809.74 (2).

(b) Treatment plant CT values shall meet the applicable requirements found in ss. NR 810.47 to 810.62 at all times.

(4) CONSTRUCTION AND MODIFICATIONS. (a) After construction, maintenance, repair or modification, waterworks facilities shall be disinfected by procedures outlined in the following A.W.W.A. Standards: A100 (August 1, 2006) for wells, C651 (June 1, 2005) for water mains, C652 (August 1, 2002) for water storage facilities, C653 (June 1, 2003) for water treatment plants or C654 (November 1, 2003) for wells. In addition, waterworks may not be placed in service until bacteriological samples have established that the water is safe for consumption in accordance with par. (b).

Note: Copies of these standards are available for inspection at the office of the Department of Natural Resources and the Legislative Reference Bureau, and may be obtained for personal use from the American Water Works Association, 6666 West Quincy Ave., Denver, Colorado, 80235.

(b) At least one bacteriologically safe sample shall be obtained before waterworks are placed into service. In the case of new or reconstructed wells, a minimum of 2 bacteriological safe samples, taken at least 8 hours apart during the test pumping period, or on 2 separate days, shall be obtained. When new distribution systems or extensions on a number of streets are installed, bacteriological samples shall be taken at representative locations to establish that all of the improvements are free of contamination. When water main breaks are repaired in public water systems that do not maintain a detectable chlorine residual, a bacteriological sample shall be taken in the area of the break within one working day. The main may be returned to service prior to receiving the results provided that the main has been disinfected and flushed. The water supplier shall comply with s. NR 809.31 when system sampling indicates the presence of coliform organisms. For water storage facilities, 2 or more successive safe samples, taken at 24−hour intervals, shall be obtained which indicate bacteriologically safe water or one safe sample shall be obtained only if a free chlorine residual of at least 0.1 mg/l is remaining when the results of the safe sample are reported.

(5) INDIRECT ADDITIVES. Written approval from the department is required prior to the use of any indirect chemical or material that may affect the quality of the water supply due to immersion or incidental contact in the water system. Department approval shall include certification of the chemical or material for use in potable water under NSF/ANSI Standard 61. Laboratories evaluating products for compliance with NSF/ANSI Standard 61 shall be certified by the American National Standards Institute. Written department approval is not required where existing equipment is being replaced with similar equipment during maintenance or repair provided that the water supplier can document that the equipment used meets the approval requirements of this section.

Note: Examples of indirect additives include process media, protective materials such as liners, paints and coatings, sealants, gaskets, fittings and lubricants.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.10 Distribution system normal pressure. For community water systems, the system pumps, the distribution system and related storage facilities shall be operated to maintain a minimum of 35 pounds per square inch and a maximum of 100 pounds per square inch at ground level above the water main at all locations in the distribution system under normal operating conditions. Normal operating conditions include the peak hour demand on the maximum day. Where the storage or primary pumping facilities cannot provide a minimum static pressure of 35 psi throughout the distribution system at street elevation it shall be necessary to create a boosted pressure zone to serve those portions of the system. The use of pressure boosting systems on individual service lines shall be limited to a maximum of 10 individual systems in any given service area. The individual pressure boosting systems shall be owned and maintained by the public water system owner. The department may require pressure testing to determine whether adequate pressures are available. In situations where static pressures exceed 100 psi, pressure reducing devices may be required on mains in distribution systems having documented system deficiencies or problems due to high pressure such as main breaks and service line breaks.

Note: Section SPS 382.40 (7) (d) 2. a. requires a pressure reducing device to be installed to protect individual services when the incoming pressure exceeds 80 psig.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.11 Distribution system fire flow pressure. Community water systems with fire protection shall be operated so that under fire flow conditions the residual pressure in the distribution system is not less than 20 pounds per square inch at ground level. Water suppliers shall maintain current flow studies showing the fire flow capability of the system. Fire pumpers may not be connected to fire hydrants if 20 psi cannot be maintained in the system during operation of the pumpers. In addition, the public water system owner shall notify the fire chief in writing of the location of all fire hydrants that cannot be used by fire pumpers and color code or tag the affected hydrants. The department may require pressure and flow testing to determine whether adequate flows and pressures are available.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.12 Distribution system loss of pressure. The water supplier for community water systems shall be responsible for taking corrective action when positive distribution system pressure is lost in an area affecting 25% or more of the overall distribution system or in an entire pressure zone. In addition to restoring system pressure, the water supplier shall perform all of the following:

(1) Notify the appropriate regional office of the department as soon as possible, but no later than one working day after the loss of pressure, as to the extent of the problem, cause and corrective actions taken.

(2) Start emergency disinfection of the water supply if the water system is not already continuously disinfected. At a minimum, the free chlorine residual shall be 0.2 mg/l at the entry point to the distribution system and detectable throughout the distribution system or the total combined chlorine residual shall be 1.0 mg/l at the entry point and detectable throughout the distribution system. If loss of pressure was limited to one pressure zone, the above disinfection requirements may be restricted to target the affected pressure zone. Higher disinfectant residuals may be required by the department if deemed necessary to ensure a safe water supply. Water mains and storage facilities in the area that lost pressure shall be flushed to remove contaminated water and

to quickly establish an adequate disinfectant residual. Emergency disinfection shall be maintained until approval is obtained from the department to cease.

(3) Collect distribution system water samples for bacteriological analyses from the pressure loss area as soon as adequate pressure is returned to the water system. The number of samples collected shall increase as the extent of problem areas increases, but in no case may less than 2 samples be collected. The department shall be contacted to determine the number of samples and sampling locations. The water supplier shall comply with s. NR 809.31 when water system sampling indicates the presence of coliform organisms.

(4) Issue an immediate boil water notice to all affected water consumers unless it is determined by the department that an acute threat to public health does not exist. The boil water notice shall be maintained until approval is obtained from the department to cease. In this subsection "boil water notice" means a special type of public notice that informs consumers that the water is bacteriologically unsafe and should be boiled prior to consumption. A boil water notice shall include all the following information:

(a) The water has tested bacteriologically unsafe for drinking.

(b) All water used for washing of eating utensils, drinking, or cooking should be boiled at a rolling boil for at least one minute.

(c) Ice and any beverages prepared with unboiled water should be discarded.

(d) Precautions listed in subd. 1 to 3 are in effect until further notice.

(5) Notify the public in the area affected as prescribed in s. NR 809.951 unless the department determines that no health hazard has existed.

(6) Take all corrective actions necessary to prevent additional pressure losses.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.13 System maintenance. Each water supplier for all public water systems shall perform routine maintenance to ensure proper operation of the public water system. Record keeping shall be established to ensure proper scheduling.

(1) Each water supplier for community and nontransient noncommunity water systems shall perform all of the following:

(a) *Well pump maintenance.* Vertical turbine and submersible well pumps shall be removed and inspected on a regular basis and maintenance provided as needed. A frequency of once every ten years is recommended.

(b) *Well seal inspection.* The seal between the pump base and pump head shall be verified to meet the requirements of ss. NR 811.31 (1) or 811.32 (1) each time a pump is installed or reinstalled.

(c) *Vessels.* Iron filters, softeners, and other similar closed treatment vessels shall be opened up, where practicable, and inspected at a minimum of once every 5 years.

(d) *Emergency power exercising.* Emergency generators and auxiliary engines shall be exercised a minimum of once per month and quarterly under full load. A log shall be kept that documents when the unit was operated and maintenance that was performed on the unit. Water suppliers for those public water systems who rent, lease or borrow their generators shall have a contract with the owner of the unit, perform full−load exercising at least annually, and keep records showing when exercising was performed. Water suppliers for those public water systems with right angle units requiring mobile tractors shall perform full load exercising at least annually and keep records showing when exercising was performed. Operational and fueling procedures shall be included in the log.

(e) *Hydropneumatic tanks.* Pressure tanks shall be flushed regularly to remove sediment. Tanks equipped with hatches shall have interior inspections a minimum of once every 5 years. Maintenance shall include removal of sediment, cleaning of biofilm, restoration of interior and exterior coating systems to prevent corrosion, cleaning and repair of sight glasses, air volume controls and exercising valves.

(2) Unless an alternate schedule is approved by the department, each water supplier for community water systems shall perform all of the following:

(a) *Valve exercising.* All distribution system valves shall be exercised a minimum of every 2 to 5 years. The department recommends 5 to 7 years for hydrant lead auxiliary valves.

(b) *Hydrant exercising.* All hydrants shall be exercised at least once every 2 years.

(c) *Hydrant maintenance.* Hydrants shall be maintained in proper working condition, consistent with the manufacturer's recommendations.

(d) *Flushing dead−end mains.* A schedule shall be established for flushing dead−end mains or mains in other areas to remove sediment or water of poor quality.

(e) *Meter testing and calibration.* For water utilities serving public water systems, master water meters in wellhouses, high lift pumping stations, booster pumping stations and metering stations shall be tested and calibrated at a minimum frequency of every 2 years or as required by s. PSC 185.83 (2). Calibration results shall be documented and be within acceptable levels for the particular meter being calibrated.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.14 Water storage facility inspections. The interior and exterior of water storage facilities serving public water systems shall be regularly inspected and maintained. Inspections of storage facilities 10,000 gallons or greater shall be by a professional tank inspection firm or by a registered professional engineer. Maintenance shall include removal of sediment and biofilm prior to evaluation of structural, mechanical and coating systems. Repairs shall be provided as necessary to ensure good working condition. Interior and exterior paint coatings for steel elevated water storage tanks or treatment structures shall be inspected by a person trained to evaluate the integrity of the paint system and repainted as necessary to maintain structural integrity. The water supplier may perform the inspection if experienced in paint inspection.

(1) FREQUENCY. All storage facilities shall be inspected a minimum of every 5 years and as required in sub. (2) (a) unless otherwise approved by the department. Repairs or welding on the exterior of a tank may make a special interior inspection necessary. Exterior inspections of vent and overflow screens and hatches shall be conducted once per year by the water supplier.

(2) METHODS. Any of the following methods are acceptable for the required 5−year interior tank/ water storage facility inspection:

(a) *Drain down inspections.* Drain down inspections include completely draining the tank. Rigging and ladders may be necessary to access all surfaces. The tank shall be cleaned of all sediment prior to inspecting. Unless an alternative schedule is approved by the department, a drain down inspection shall be utilized a minimum of every ten years or every other inspection.

1. Following all drain down inspections and painting, the interior of the tank shall be disinfected in accordance with one of the methods in AWWA Standard C652−02. A minimum of 2 successive safe samples, taken at 24−hour intervals, shall be obtained which indicate bacteriologically safe water; or one safe sample shall be obtained only if a free chlorine residual of at least 0.1 mg/l is remaining when the results of the safe sample are reported.

2. For all concrete ground reservoirs with cracks or signs of leakage, the top shall be soaked with water and the interior shall be checked for leaks.

(b) *Float down or partial drain inspections.* Float down inspections involve the use of a disinfected inflatable raft and allow access to all levels of the tank. The water level shall be lowered below the normal low operating level to expose the sidewalls of the tank. If the tank is to remain in service during the inspection

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or the water will be sent to the distribution system following the inspection, all of the following requirements apply:

1. A minimum 0.5 mg/l chlorine residual shall be maintained in the tank throughout the inspection.

2. All equipment shall be dedicated for potable water use and is disinfected with a 200 ppm chlorine solution.

3. For all concrete ground reservoirs with cracks or signs of leakage, the top shall be soaked with water and the interior shall be checked for leaks.

4. A minimum of 2 bacteriologically safe samples shall be obtained from the tank after the inspection, one following the inspection and one 24 hours later.

5. A minimum pressure of 35 psi shall be maintained throughout the distribution system during the inspection.

(c) *Diver inspections.* Diver inspections shall involve the use of a commercial diver tethered to, and in communication with, the outside. Procedures shall be done in accordance with Section 4.4 of AWWA Standard C652−02 and Section 12.0 of the Consensus Standards for Commercial Diving and Underwater Inspection. The department recommends that the tank be removed from service during the inspection. If the tank is to remain in service during the inspection or if the water will be sent to the distribution system following the inspection, all of the following requirements apply:

1. A minimum 0.5 mg/l chlorine residual shall be maintained in the tank throughout the inspection.

2. All equipment shall be dedicated for potable water use and shall be disinfected with a 200 ppm chlorine solution. The inspector shall also be disinfected.

3. The inspection of the tank shall be done after the sediment is removed from the bottom of tank and shall include a visual inspection of any expansion joints.

4. For all concrete ground reservoirs with cracks or signs of leakage, the top shall be soaked with water and the interior shall be checked for leaks.

5. A minimum of 2 bacteriologically safe samples shall be obtained from the tank after the inspection, one following the inspection and one 24 hours later.

(d) *Robotic inspections.* Robotic inspections shall involve a rover unit with a fiber optic tether and video camera and shall include cleaning capabilities. If the tank is to remain in service during the inspection or if the water will be sent to the distribution system following the inspection, all of the following requirements apply:

1. A minimum 0.5 mg/l chlorine residual shall be maintained in the tank throughout the inspection.

2. All equipment entering the tank shall be dedicated for potable water use and be disinfected with a 200 ppm chlorine solution.

3. For all concrete ground reservoirs with cracks or signs of leakage, the top shall be soaked with water and the interior shall be checked for leaks.

4. A minimum of 2 bacteriologically safe samples shall be obtained from the tank after the inspection, one immediately following the inspection and one 24 hours later.

(3) DEPARTMENT NOTIFICATION. The department's regional drinking water staff person shall be given 48 hours prior notice of the date and time of the inspection.

(4) INSPECTION REPORT SUBMITTAL. Upon completion of the water storage facility inspection, a completed department report form shall be submitted to the department's regional drinking water staff person documenting the condition of the storage facility. The water supplier shall submit copies of any additional reports and videos prepared by the inspector.

Note: The report forms are available from the department's regional or central office drinking water program staff.

(5) MANHOLE COVER GASKET. Following all inspections and maintenance, the integrity of the gasket between the access manhole cover and curbing shall be checked and replaced if necessary to prevent the entrance of dust and insects. If no gasket is present, one meeting s. NR 811.64 (7) requirements shall be provided to prevent the entrance of dust and insects.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.15 Cross connections and interconnections. Unprotected cross−connections are prohibited. Cross−connections shall be protected as required in s. SPS 382.41. Water system interconnections are prohibited except as provided in sub. (2). In addition the following requirements shall be met:

(1) CROSS CONNECTION CONTROL PROGRAM. In order to protect the public water supply system, the water supplier for every municipal water system shall develop and implement a comprehensive cross connection control program for the elimination of all existing unprotected cross−connections and prevention of all future un−protected cross connections to the last flowing tap or end−use device. The program may include providing public education materials in lieu of inspections of low hazard portions of residential or commercial facilities. Low hazard areas consist of normal kitchen and bathroom fixtures. The water supplier shall keep a current record of the cross connection control program available for annual review by the department. The cross connection control program shall include:

(a) A complete description of the program and the administration procedures, including designation of the inspection or enforcement agency or agencies.

(b) Local authority for implementation of the program, such as ordinance or other governing rule.

(c) A time schedule for public education materials, surveys and follow up surveys of consumer premises for cross connections including appropriate record keeping. Unless otherwise authorized by the department, water suppliers for each municipal water system shall cause a survey to be conducted for every residential service a minimum of once every ten years or on a schedule matching meter replacement. Public educational materials, when being provided in lieu of low hazard inspections, shall be provided to the customer no less than every 3 years and with every cross connection survey. Unless a detailed alternative schedule is included in the cross connection control program and is approved by the department, water suppliers for each municipal water system shall cause a survey to be conducted for every industrial, commercial and public authority service a minimum of once every 2 years. Commercial properties of similar or lesser risk to residential properties may follow the same schedule as residential properties. Completed survey results shall be maintained by the water supplier until corrections and follow up surveys have been made.

(d) A complete description of the methods, devices, and assemblies which will be used to protect the potable water supply. Compliant methods, devices and assemblies are listed in s. SPS 382.41.

(e) Provisions for denial or discontinuance of water service, after reasonable notice, to any premises where an unprotected cross connection exists or where a survey could not be conducted due to denial.

(f) Submission to the department of a copy of an ordinance establishing a cross connection control program, an annual report including a total number of all service connections by category, and a report indicating the number of surveys completed in each category for that year.

(2) INTERCONNECTIONS WITH OTHER ACCEPTABLE WATER SOURCES. Interconnections between the public water supply system and another source of water are prohibited unless permitted by the department in individual cases. Approval of the department shall be obtained prior to the interconnection.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10; **correction in (intro), (1) (d) made under s. 13.92 (4) (b) 7., Stats., Register January 2012 No. 673.**

NR 810.16 Local well regulation program. Water suppliers for municipal water systems and communities served by a municipal water system, shall implement a program for the regulation of wells which are not part of the municipal water system

and are located on premises served by the municipal water system. Regulation is required to prevent unused, unsafe and noncomplying wells from acting as vertical conduits for aquifer contamination or as sources of unsafe water that could enter the public water system through cross connections. Implementation shall be by local ordinance or utility rule. The ordinance or rule shall include:

(1) A requirement that all water supply wells that do not have valid operational permits issued pursuant to sub. (2), wells which are not routinely used, wells which are in noncompliance with ch. NR 812, or wells which test bacteriologically unsafe, shall be properly sealed and abandoned in accordance with ch. NR 812 by an established date not to exceed one year from date of connection to the public system, or date of discovery or construction.

(2) Provisions for a well operation permit renewable not less frequently than every 5 years that will allow retention and operation of wells which are safe and in compliance with ch. NR 812 with the limitation that the well shall be functional and the owner shall demonstrate a need for use. The permit shall require:

(a) That a minimum of one safe sample be taken prior to issuing or reissuing the permit to establish that the water is bacteriologically safe.

(b) That the well and pump system be evaluated by a licensed well driller or pump installer and certified to comply with ch. NR 812 subch. IV, prior to issuing the initial permit and no less than every 10 years afterwards.

(c) Prohibition of unapproved cross−connections between any private well and pump installations and the municipal water system.

(3) Written documentation of the well and pump inspection indicating compliance with ch. NR 812 requirements using standardized forms provided by the department.

(4) Submission of a copy of the well regulation ordinance or rule to the department.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.17 Temporary water supply and pressure. **(1)** Water conduits used for the temporary supply of water because of water main breaks or replacement shall be of materials approved either by ch. SPS 382 as water service or private water main materials or by ch. NR 811 as water main materials. Piping materials may be reused but may not have been previously used for purposes other than providing potable water. The lines shall be disinfected in accordance with AWWA Standard C651−05.

(2) Fire hoses may be used for emergency service to customers. However, the water consumers shall be notified by the water supplier not to use the water provided for drinking or food preparation.

(3) Distribution systems or pressure zones served by a single elevated tank shall maintain normal pressures as specified in s. NR 810.10 when the tank is taken out of service for inspection and maintenance by one of the following methods:

(a) Installation of one or more pressure blow−off valves on a hydrant or hydrants at the opposite end of the system from the source of water.

(b) Installation of a temporary pressure tank connected to the system through a fire hydrant. The hydrant shall be flushed and disinfected prior to being connected to the pressure tank. The connection shall be with a reinforced high pressure neoprene hose dedicated for potable water use. An air compressor or other suitable means shall be provided to add air to the tank. All compressors used to routinely add air to tanks shall be oil−less. Larger capacity compressors that are not oil−less may be used temporarily to fill a tank upon startup, repair or service but shall be fitted with a filter and any other appurtenances necessary to remove particulates and oil. The pressure tank and connecting hose shall be disinfected and sampled in accordance with s. NR 810.09 (4). Adequate security measures shall be provided for the tank and hose.

(4) The connection to a hydrant for purposes other than fire fighting shall meet the requirements in s. SPS 382.41.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10; **correction in (1) and (4) made under s. 13.92 (4) (b) 7., Stats., Register January 2012 No. 673.**

NR 810.18 System loss and unaccounted water. All public water systems regulated by the public service commission shall be operated to comply with s. PSC 185.85 that defines system losses and sets standards for unaccounted−for water.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.19 Discharge of system or backwash water. Water discharged to the ground surface or storm sewers as part of flushing the distribution system, draining or disinfecting reservoirs, or as part of operation of a water treatment facility shall comply with the applicable general permit to discharge under the Wisconsin pollutant discharge elimination system (WPDES) as per the provisions of ch. 283, Stats. Discharge directly to a surface water is prohibited unless specific approval is obtained prior to the discharge.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.20 Approval of operational changes or maintenance projects. Water suppliers shall notify the department of any operational changes involving adjustment of chemical addition, filtration, or other operational parameters that may impact the quality of water produced. Temporary changes to manage water quality variations do not require department approval provided the operation remains within prior approved target ranges. Use of alternate chemicals, adjustment outside prescribed treatment ranges previously approved by the department, or permanent operational changes may not be made unless approved by the department prior to the change.

Note: Modifications of chemical dosages or changes in chemicals may significantly alter the corrosion characteristics of the water as well as impart odors and tastes. Careful consideration of the impact to water chemistry should be given prior to adjusting chemical treatment.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.21 Unattended water treatment plant operation. Water treatment plants may be operated remotely or by use of on site supervisory control and data acquisition (SCADA) systems provided the water distribution system has sufficient storage, as determined by engineering analysis, to allow response and resolution to problems. Unattended water treatment plants treating for acute contaminants shall be provided with:

(1) Alarms for all critical features including:

(a) Pump failure.

(b) Reservoir, clearwell, or basin overflow or low level.

(c) Station flooding.

(d) Chemical feeder failure.

(e) Chemical feed over or under desired range.

(f) Critical equipment failure.

(g) Intrusion.

(h) Power failure.

(2) An operations manual describing alarms, operator responses to alarms, quality control and challenge testing for the communication and control systems, operation and maintenance of the control systems, and identifying primary and secondary responders.

(3) A flow diagram showing the location of critical features, alarms, and automated controls.

(4) Manual override of all treatment plant operations and functions.

(5) Daily on−site operator visits to verify plant operation and security.

(6) Designation of standby operators during times of unattended operation.

(7) Battery back up for control systems.

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(8) Continuous disinfectant residual and turbidity monitoring where appropriate.

(9) Water suppliers for public water systems using surface water and groundwater under the direct influence of surface water shall:

(a) Submit a report describing the items required in sub. (2) to the department for review and approval.

(b) Demonstrate the operation of the treatment plant by the SCADA system for a period of 6 months.

(c) Provide a list of alarms generated during the demonstration period along with a request for approval to operate unattended.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.22 Emergency well operation. An emergency well is a well that is not routinely used. The well owner may obtain a written extended well abandonment agreement with the department to allow a normally unused or standby well to remain operational and to delay well abandonment provided that the well owner agrees in writing to the following requirements:

(1) The well water entering the distribution system may not exceed any bacteriological or nitrate drinking water standards.

(2) The well water may not contain any volatile organic or synthetic organic contaminant levels exceeding the maximum contaminant level or MCL that could lead to further water quality degradation of the groundwater.

(3) The well owner agrees to a 5 year cycle of reevaluation. Where the agreement is continued, it shall be renewed in writing every 5 years.

(4) A 6−year cycle for water quality monitoring is established.

(5) Bacteriological testing is conducted quarterly from the well.

(6) Nitrate is monitored annually from the well.

(7) The well meets current well construction and pump installation standards.

(8) The water supplier shall notify all customers of the use of the well if the water quality exceeds primary drinking water standards.

(9) The well owner agrees to televise any well in excess of 70 years old at least once every 15 years.

(10) The water system will restrict the use of the well if the water quality exceeds the primary drinking water standards to emergency use of no more than 2 days per quarter. The department may authorize an extended period of use for an individual event if contacted by the water supplier.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.23 Water system security and emergency operations. (1) WATER SYSTEM SECURITY. Water system buildings and infrastructure access points above ground, such as reservoir hatches, lines used to pump to waste, doors and valve chambers, shall have adequate locks and be secured when not occupied or in use. Security measures that may be taken include: the installation of security fences, hardened or protected locks, exterior warning lights, exterior motion detectors, surveillance cameras; door, window, and hatch intrusion alarms, room motion sensors, steel doors, minimizing the size of windows, eliminating windows or using hardened window materials or iron, steel bars, or mesh over windows. Any security alarms installed shall be connected to telemetry control, SCADA systems, and monitored alarm systems where they are used.

(2) EMERGENCY OPERATIONS. Water suppliers for each community water system shall develop a plan to prepare for, respond to, mitigate and recover from all types of emergency situations, including terrorism, sabotage, natural disasters such as floods and tornadoes, loss of system−wide pressure, and overfeed of chemicals.

(a) Municipal water systems shall have an emergency operation plan including, at a minimum:

1. A list of local and state emergency contacts.

2. A system for establishing emergency communications.

3. Any mutual aid agreements the water utility has with other communities for sharing personnel, equipment and other resources during an emergency.

4. Standard procedures for emergency water production.

5. A means for sharing information with customers.

(b) Other−than−municipal water systems shall have an emergency operation plan including at a minimum:

1. A list of plumbers, electricians or other contractors that would be available to respond in emergency situations.

2. Procedures for obtaining a back−up water source.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.24 Water system capacity. All new community and non−transient non−community water systems shall develop and maintain adequate financial, managerial and technical capacity to meet the requirements of this chapter and 42 USC 300f to 300j−26. New community and non−transient non−community water systems are defined as those constructed after September 1, 1999, or those that upgrade system type after that date to become a community or nontransient noncommunity water system.

Note: 42 USC 300f to 300j−26 is entitled the federal Safe Drinking Water Act.

(1) NEW SYSTEM CAPACITY EVALUATION. No new community or non−transient non−community water system may commence operation after September 1, 1999, unless the owner of the proposed water system first demonstrates to the satisfaction of the department that the water system shall have and shall maintain adequate financial, managerial and technical capacity to meet the requirements of this chapter and the requirements of 42 USC 300f to 300j−26. Additions to water systems constructed prior to September 1, 1999, are exempt from this requirement unless the additions resulted in an upgrade in system type.

Note: 42 USC 300f to 300j−26 is entitled the federal Safe Drinking Water Act.

(2) CAPACITY EVALUATION SUBMITTAL. To demonstrate financial, managerial and technical capacity to the department, before beginning construction of a water system, the owner of a proposed community or non−transient non−community water system shall submit to the department a system capacity evaluation that includes all of the following:

(a) A written description of the water system design that includes all of the following:

1. For groundwater systems, the proposed well construction and the name of the water−bearing formation.

2. For surface water systems, the name of the source water body and the intake length and intake location.

3. Pumping capacity.

4. Water treatment.

5. Water storage volume.

6. Length and diameter of water mains.

7. Pressure range within the water system.

8. Location of any pressure reducing valves or pressure booster stations.

9. Map or plat showing the proposed water system.

(b) Evaluation of the potential for the water quality to be out of compliance with any of the primary or secondary standards of this chapter. For groundwater systems, this evaluation shall be based on a review of water quality information available from nearby existing wells or on the results of water quality monitoring from a test well. For surface water systems, this evaluation shall be based on water quality monitoring from the surface water.

(c) Anticipated average and maximum daily water use for the proposed water system.

(d) For groundwater systems, a site assessment that includes all of the following:

1. The separation distances between the well and potential sources of contamination within the proposed wellhead protection area.

2. Any violation of the applicable separation distances contained in chs. NR 811 and 812.

3. The proximity of the well to any wetlands.

4. The location of the well in relation to the 100−year flood elevation.

(e) For surface water systems, a source water assessment that includes the identification of potential sources of contamination in relation to the intake and the susceptibility of the water system to contamination.

(f) Anticipated number of industrial, commercial and residential water services.

(g) Initial and projected customer population and service area.

(h) Information for the identification, location and contact of the water system designer including the name, address, and telephone number of the system designer and designer's firm.

(i) Status of all department permits and approvals related to the construction of the water system.

(j) Information for the identification, location and contact of the water system owner including the name, address and telephone number of the water system owner and the extent of the owner's responsibility for the water system.

(k) Information for the identification, location and contact of the water system manager including the name, address and telephone number of the system manager.

(L) Information for the identification, location, and contact of the water system operator including the name, address and telephone number of the water system's certified operator as defined in s. NR 114.03 (2). If a certified operator has not been selected prior to submitting the capacity evaluation, a timetable for hiring an operator shall be included as part of the capacity evaluation in lieu of the information for the identification, location and contact of the water system operator. The water system may not be placed into operation until the department is provided with the information for the identification, location and contact of the water system operator required in this paragraph.

(m) A plan identifying all sample locations for all monitoring required under the Safe Drinking Water Act.

(n) Description of the operational procedures required by this chapter, chs. NR 809 and 811 and PSC 185 related to wellhead protection, well abandonment, cross−connection control, operational reporting, meter testing, hydrant and valve exercising and operator certification.

(o) Description of the rate or fee mechanism for other−than−municipal water systems.

(p) Copy of the public service commission certificate authorizing the construction and operation, and estimating rates, for municipal water systems regulated by the public service commission.

(q) Description of the method of payment for the construction and operation of the water system for non−transient non−community water systems.

(r) Statement from the water system owner on the financial capacity of the water system to meet the requirements of this chapter.

(3) CAPACITY EVALUATION FORM. The capacity evaluation shall be submitted on a form provided by the department or in a format approved by the department.

Note: Capacity evaluation forms may be obtained from the department bureau of drinking water and groundwater at no charge by writing to Bureau of Drinking Water and Groundwater, Box 7921, Madison, WI 53707.

(4) REQUIRED QUALIFICATIONS. The information in sub. (2) (a) to (e) shall be prepared by a professional engineer for municipal water systems and by a professional engineer or licensed well driller for other−than−municipal or non−transient non−community water systems.

(5) WAIVER PROCEDURE FOR NON–COMMUNITY WATER SYSTEMS. The department may waive the requirement for the owner to supply information on well construction, well location, water quality monitoring, and operational procedures listed in sub. (2) (a) to (n) for non−community water systems provided that the owner acknowledges in writing conformance to the requirements for well construction, well location, water quality monitoring, and water system operation contained in this chapter and ch. NR 812.

(6) ENGINEERING OR DESIGN REPORT. A single engineering or design report may be submitted to satisfy the requirements of s. NR 811.09 (3) and (4) and the capacity evaluation required by sub. (2).

(7) DEPARTMENT APPROVAL OF SYSTEM CAPACITY. The construction of any new non−transient non−community or community water system may not commence without department approval of the system capacity evaluation demonstrating technical, financial, and managerial capacity required in this section.

(8) DENIAL OF WATER SYSTEM CAPACITY. The department may deny approval of the system capacity evaluation for any of the following reasons:

(a) The water system design does not conform to the applicable design and location standards, or approved variances to the standards, contained in chs. NR 811 and 812 and SPS 382.

(b) The water system operational procedures do not meet the applicable requirements of ch. PSC 185 or of this chapter and ch. NR 811 related to wellhead protection, well abandonment, cross−connection control, operational reporting, meter testing, hydrant and valve exercising, and operator certification.

(c) The water system monitoring plan does not conform to the applicable monitoring requirements of this chapter and ch. NR 809, approved variances to the requirements of this chapter and ch. NR 809, or to monitoring requirements established as part of the department construction approval under chs. NR 811 and 812.

(d) The system capacity evaluation is incomplete.

(e) The information provided does not demonstrate adequate financial capacity to meet the requirements of this chapter.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10; **correction in (8) (a) made under s. 13.92 (4) (b) 7., Stats., Register January 2012 No. 673.**

NR 810.25 Operation and maintenance manuals. Water suppliers for all community water systems providing treatment, including chemical addition, shall provide training for staff in the operation and maintenance of the equipment and maintain up−to−date manuals for the operation and maintenance of the equipment.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.26 Other requirements. (1) AUTHORIZATION FOR OPERATION OF NEW COMMUNITY WATER SYSTEMS OR IMPROVEMENTS TO EXISTING SYSTEMS. Before a new community water system or improvements to a community water system can be placed into service, written authorization of the department shall be obtained.

(a) To obtain authorization for operation of a new community water system, the community water system owner shall meet the following requirements:

1. An inspection of the facilities shall be made by a representative of the department to determine if construction is in accordance with the approved plans and specifications. Deficiencies shall be corrected prior to startup or by a specified compliance date, as determined by the significance of the deficiency.

2. The department shall be informed in writing of the name of the certified operator who will be in charge of any community water system.

3. The owner of a municipal water system shall have adopted cross−connection and well abandonment ordinances or rules.

4. The owner of a municipal water system shall have an approved wellhead protection plan.

5. The owner of each community water system shall have an emergency response plan.

6. Water distribution maps as required in sub. (2) shall be provided to the department by the water supplier.

7. A plan identifying all sample locations for all monitoring required under the Safe Drinking Water Act shall be provided to the department by the water supplier.

File inserted into Admin. Code 2−1−2012. May not be current beginning 1 month after insert date. For current adm. code see:
http://docs.legis.wisconsin.gov/code/admin_code

(b) To obtain authorization for startup of improvements to existing community water systems that are reviewable projects as defined in s. NR 108.02 (13), an inspection of the facilities and correction of deficiencies may be necessary prior to startup as required in par. (a). Water mains are excluded from the inspection requirement unless required in the department plans and specifications approval letter.

(2) MAPS. Each municipal and OTM subdivision water supplier shall supply a current map of the public water system which shows the size and location of all facilities and appurtenances, such as water mains, valves, hydrants, wells or sources, pumping stations, treatment plants, and storage facilities. Overflow elevations of the water system storage units shall be shown. Any pressure zones shall be delineated. Two current copies of this map shall be kept on file with the department at all times. One copy shall be provided to the department's central office and one copy shall be provided to the appropriate department regional office.

(3) METERS. Each municipal water supplier and those water suppliers for other−than−municipal water systems having a source capacity of at least 70 gallons per minute shall provide a water meter at each source to accurately measure the daily quantity of water pumped or delivered. Water metering shall be provided for all community water systems utilizing chemical addition. All source water meters shall be calibrated at least every 2 years as required in s. PSC 185.83 (2).

(4) LICENSED PUMP INSTALLER. Any person, firm, corporation or partnership performing well pump installing work as defined in s. 280.01 (5), Stats., shall perform the work in accordance with chs. NR 108, 811, and 812 and shall be a licensed pump installer in accordance with the requirements of ch. NR 146. Pump installing work at municipal water systems is not required to be performed by a licensed pump installer when performed by a department certified waterworks operator who is a full−time employee of the municipal water system.

Note: Section 280.01 (5), Stats., defines "pump installing" to mean the industry and procedure employed in the placement and preparation for operation of equipment and materials utilized in withdrawing or obtaining water from a well for consumption or use, including all construction involved in making entrance to the well and establishing such seals and safeguards as are necessary to protect such water from contamination.

(5) WELL HEAD PROTECTION PLANS. Water suppliers for community water systems with a department approved well head protection plan and ordinance shall implement it. Amended plans or ordinances shall be approved by the department prior to implementation.

(6) SAMPLING AND MONITORING PLANS. Water suppliers shall develop sampling and monitoring plans as required by ss. NR 809.31 (1) (a), 809.325 (2) (c), and 809.565 (6).

(7) STORAGE TURNOVER. Storage facilities shall be operated to facilitate turnover of water in order to prevent freezing and stagnant water conditions. Consideration shall be given to installing separate inlet and outlet pipes, diffusers and baffle walls.

(8) EMERGENCY CHLORINATION PLANS. An emergency chlorination plan is required for each community water system. Each municipal water system shall have appropriate chlorination infrastructure and chorine available to obtain 0.5 mg/l free chlorine throughout its distribution system within 4 hours. A working chlorine meter shall also be available to measure chlorine concentrations. To ensure water systems are capable of emergency chlorination, the department may ask that an emergency chlorination test be conducted by the water supplier for a municipal water system. At a minimum, the emergency chlorination plan shall include:

(a) Location and description of chlorine pumps, solution containers, chemical, and chlorine test meter.

(b) Procedures for adding chlorine to the water system, flushing the water system to move chlorine to extremities, and testing chlorine levels.

(c) Example calculations for determining dosage requirements.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10; correction in (6) made under s. 13.92 (4) (b) 7., Stats., Register November 2010 No. 659.

Subchapter II — Surface Water Treatment and Groundwater Under the Direct Influence of Surface Water Treatment Operations

NR 810.27 General requirements for all surface water and groundwater under the direct influence of surface water systems. (1) This subchapter establishes criteria under which filtration is required as a treatment technique for public water systems supplied by a surface water source or a groundwater source under the direct influence of surface water. Direct influence shall be determined for individual sources by the department. The department determination of direct influence may be based on site−specific measurements of water quality characteristics such as those stated in s. NR 810.02 (25) or documentation of well construction characteristics and geology with field evaluation. These regulations also establish requirements for treatment techniques in lieu of maximum contaminant levels for *Giardia lamblia,* viruses, heterotrophic plate count bacteria, *Legionella, Cryptosporidium* and turbidity. Treatment technique requirements apply to every public water system which utilizes surface water or groundwater under the direct influence of surface water and the requirements consist of installing and properly operating water treatment processes which reliably achieve:

(a) At least 99.9% or 3−log removal 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.

(b) At least 99.99% or 4−log removal 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.

(c) At least 99.9% or 3−log removal of *Cryptosporidium* 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 filtered systems, or *Cryptosporidium* control under the watershed control system for unfiltered GWUDI systems.

(2) A public water system using a surface water source is considered to be in compliance with the requirements of sub. (1) if it meets the filtration requirements in s. NR 810.29 and the disinfection requirements in s. NR 810.31.

(3) A public water system using groundwater under the direct influence of surface water is considered to be in compliance with the requirements or sub. (1) if it meets the criteria for avoiding filtration in s. NR 810.30 along with the disinfection requirements in s. NR 810.31; or if it meets the filtration requirements in s. NR 810.29 and it meets the disinfection requirements in s. NR 810.31.

(4) Each public water system using a surface water source or a groundwater under the direct influence of surface water shall be operated by qualified personnel who meet the requirements specified by the department.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.28 Requirements for covers on water storage structures. All finished water storage reservoirs and treatment plant basins shall be covered. Finished water is that water which has received all required treatment. Treatment plant basins contain water at various stages of treatment.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.29 Basic filtration requirements. Public water systems that use a surface water source shall provide filtration which complies with the requirements of sub. (1), (2), (3), (4), or (5) and meets the disinfection criteria specified in s. NR 810.31

(2). Public water systems that use a groundwater source under the direct influence of surface water shall provide filtration which complies with the specifications of sub. (1), (2), (3), (4) or (5) and meets the disinfection criteria specified in s. NR 810.31 (2) within 18 months of the date that a source is determined, by the department, to be under the direct influence of surface water unless they meet the filtration avoidance criteria in s NR 810.30. Failure to meet the applicable requirements of this section is a treatment technique violation.

(1) CONVENTIONAL FILTRATION TREATMENT. (a) For systems using conventional filtration treatment, the turbidity level of representative samples of a system's filtered water shall be less than or equal to 0.3 nephelometric turbidity units (NTU) in at least 95% of the measurements taken each month, measured as specified in s. NR 809.113 (1) Tables A and B.

(b) The turbidity level of representative samples of a system's filtered water may not exceed one NTU, measured as specified in s. NR 809.113 (1) Tables A and B.

(c) To determine compliance with par. (a), turbidity measurements shall be performed on representative samples of filtered water at least every 4 hours that the system serves water to the public.

(d) In lieu of the requirements of par. (c), turbidity measurements from a continuous reading and recording turbidity monitoring device shall be recorded at predetermined 4−hour intervals to determine compliance with par. (a). The highest turbidity measurement recorded at any time during the day shall be reported under s. NR 809.80 (7) (a) 1.

(e) A system that uses lime softening may acidify representative samples prior to analysis if using a protocol approved by the department.

(2) DIRECT FILTRATION. (a) For systems using direct filtration, the turbidity level of representative samples of a system's filtered water shall be less than or equal to 0.3 NTU in at least 95% of the measurements taken each month, measured as specified in s. NR 809.113 (1), Tables A and B. The department may approve a turbidity limit up to one NTU if the water supplier provides the department with documentation which reliably indicates the system achieves at least 99.9% removal or inactivation of *Giardia lamblia* cysts at a turbidity level above 0.5 NTU at least 95% of the time that the system delivers water to the public.

(b) The turbidity level of representative samples of a system's filtered water may not exceed 1 NTU, measured as specified in s. NR 809.113 (1), Tables A and B.

(3) SLOW SAND FILTRATION. (a) For systems using slow sand filtration, the turbidity level of representative samples of a system's filtered water shall be less than or equal to 1 NTU in at least 95% of the measurements taken each month, measured as specified in s. NR 809.113 (1), Tables A and B.

(b) The turbidity level of representative samples of a system's filtered water may not exceed 5 NTU, measured as specified in s. NR 809.113 (1), Tables A and B.

(4) DIATOMACEOUS EARTH FILTRATION. (a) For systems using diatomaceous earth filtration, the turbidity level of representative samples of a system's filtered water shall be less than or equal to one NTU in at least 95% of the measurements taken each month, measured as specified in s. NR 809.113 (1), Tables A and B.

(b) The turbidity level of representative samples of a system's filtered water may not exceed 5 NTU, measured as specified in s. NR 809.113 (1), Tables A and B.

(5) OTHER FILTRATION TECHNOLOGIES. A public water system may use a filtration technology not listed in subs. (1) to (4) if the water supplier for the system demonstrates to the department, using pilot studies or other means, that the alternative filtration technology, in combination with disinfection treatment that meets the requirements of s. NR 810.31, consistently achieves 99.9% removal or inactivation of *Giardia lamblia* cysts and 99.99% removal or inactivation of viruses, and 99.9% removal of *Cryptosporidium* oocysts, and the department approves the use of the filtration technology. For each approval, the department shall set turbidity performance requirements that the water system shall meet at least 95% of the time at a level that consistently achieves 99.9% removal or inactivation of *Giardia lamblia* cysts, 99.99% removal or inactivation of viruses, and 99% removal of *Cryptosporidium* oocysts. The department may set other performance requirements to assure the integrity of the technology.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.295 Filter backwash handling. Public water systems that use a surface water source or groundwater under the direct influence of surface water and that provide filtration shall meet the requirements of s. NR 811.860.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.30 Criteria for avoiding filtration for groundwater under the direct influence of surface water systems. A public water system that uses groundwater under the direct influence of surface water as a water supply source shall meet all of the conditions of subs. (1) and (2), and is subject to sub. (3), unless the department has determined, in writing, that filtration is required. If the department determines in writing that filtration is required, the water system owner shall install filtration and shall meet the criteria for filtered systems specified in ss. NR 810.29 and 810.31 (2). Within 18 months of the failure of a public water system using a groundwater source under the direct influence of surface water to meet any one of the requirements of subs. (1) and (2), the water system owner shall install filtration and shall meet the criteria for filtered systems specified in ss. NR 810.29 and 810.31 (2).

(1) SOURCE WATER QUALITY CONDITIONS. (a) The fecal coliform concentration shall be equal to or less than 20/100ml, or the total coliform concentration shall be equal to or less than 100/100 ml, measured as specified in s. NR 809.311 (1) Table F, in representative samples of the source water immediately prior to the first or only point of disinfectant application in at least 90% 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 shall be met.

(b) The turbidity level may not exceed 5 NTU, measured as specified in s. NR 809.113 (1) Tables A and B, in representative samples of the source water immediately prior to the first or only point of disinfectant application unless both of the following apply:

1. The department determines that a turbidity "event" was caused by circumstances that were unusual and unpredictable. A turbidity "event" is a series of consecutive days during which at least one turbidity measurement each day exceeds 5 NTU.

2. There have not been more than 2 turbidity events in the past 12 months the water system served water to the public, or more than 5 turbidity events in the past 120 months the system served water to the public.

(2) SITE–SPECIFIC CONDITIONS. (a) 1. The public water system shall meet the disinfection requirements of s. NR 810.31 (1) (a) 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 department determines that at least one of these failures was caused by circumstances that were unusual and unpredictable.

2. The public water system shall meet the requirements of s. NR 810.31 (1) (b) at all times the system serves water to the public.

3. The public water system shall meet the requirements of s. NR 810.31 (1) (c) at all times the system serves water to the public unless the department determines that any failure was caused by circumstances that were unusual and unpredictable.

4. The public water system shall meet the requirements of s. NR 810.31 (1) (d) on an ongoing basis unless the department determines that failure to meet these requirements was not caused by a deficiency in treatment of the source water.

(b) The public water system shall maintain a department approved wellhead protection program which minimizes the

potential for contamination by *Cryptosporidium, Giardia lamblia* cysts and viruses in the source water. The department shall determine whether the well head protection program is adequate to meet this goal. At a minimum, the program shall do all of the following:

1. Characterize the watershed hydrology, hydrogeology, and land ownership.

2. Identify watershed characteristics and activities which may have an adverse effect on source water quality.

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

(c) The public water system is subject to an annual on−site inspection to assess the well head protection program and disinfection treatment process. Either the department or a party approved by the department shall conduct the on−site inspection. The inspection shall be conducted by competent individuals and shall include all of the following:

1. A review of the effectiveness of the watershed control program.

2. A review of the physical condition of the source intake and how well it is protected.

3. A review of the system's equipment maintenance program to ensure there is low probability for failure of the disinfection process.

4. An inspection of the disinfection equipment for physical deterioration.

5. A review of operating procedures.

6. A review of data records to ensure that all required tests are being conducted and recorded and disinfection is effectively practiced.

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

8. A review of the adequacy of the watershed control program to limit potential contamination by *Cryptosporidium* including: 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 or controlled land use, or both, within the watershed.

(d) The public water system may not have been identified as a source of a waterborne disease outbreak, or if it has been so identified, the system shall be modified sufficiently to prevent another occurrence, as determined by the department.

(e) The public water system shall comply with the maximum contaminant level (MCL) for total coliforms in s. NR 809.30 at least 11 months of the previous 12 months that the system served water to the public, on an ongoing basis, unless the department determines that failure to meet this requirement was not caused by a deficiency in treatment of the source water.

(f) The public water system shall comply with the requirements for total trihalomethanes, five haloacetic acids, bromate, chlorite, chlorine, chloramines and chlorine dioxide in s. NR 809.561.

(3) TREATMENT TECHNIQUE VIOLATIONS. (a) A public water system that fails to meet any one of the criteria in subs. (1) and (2), and for which the department has determined in writing that filtration is required, is in violation of a treatment technique requirement.

(b) A public water system that has not installed filtration is in violation of a treatment technique if either of the following apply:

1. The turbidity level in a representative sample of the source water immediately prior to the first or only point of disinfection application exceeds 5 NTU.

2. The system is identified as a source of a waterborne disease outbreak.

(4) ADDITIONAL CIRCUMSTANCES WHEN FILTRATION WOULD BE REQUIRED. The department may require a public water system to install filtration even when the system meets the requirements of subs. (1) and (2) if other water quality characteristics or site specific conditions present a threat to public health which could not be eliminated by disinfection alone.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.31 Disinfection requirements for *Giardia lamblia* and viruses. A public water system that uses groundwater under the direct influence of surface water and does not provide filtration shall provide disinfection treatment specified in sub. (1) within 18 months after the department determines that the groundwater source is under the influence of surface water. A system that filters and uses surface water or groundwater under the direct influence of surface water as a source shall provide the disinfection treatment specified in sub. (2) when filtration is installed. Failure to meet any requirement of this section is a treatment technique violation.

(1) DISINFECTION REQUIREMENTS FOR PUBLIC WATER SYSTEMS USING GROUNDWATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER THAT DO NOT PROVIDE FILTRATION. (a) The disinfection treatment shall be sufficient to ensure at least 99.9% (3 log) inactivation of *Giardia lamblia* cysts and 99.99% (4 log) inactivation of viruses, every day the system serves water to the public. Each day a system serves water to the public, the water supplier shall calculate the CT value from the system's treatment parameters using the procedure specified in s. NR 810.38 (1) (d), and determine whether this value is sufficient to achieve the specified inactivation rates for *Giardia lamblia* cysts and viruses. Water suppliers for systems using a disinfectant other than chlorine shall demonstrate to the department through on−site challenge studies or other information that the system is achieving required minimum inactivation rates.

(b) The disinfection system shall have either 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 automatic shut−off of water delivery to the distribution system whenever there is less than 0.2 mg/l of residual disinfectant concentration in the water. If the department determines that automatic shut−off of delivery of water to the distribution system would cause an unreasonable risk to health or property, the disinfection system shall have redundant components.

(c) The residual disinfectant concentration in the water entering the distribution system, measured as specified in s. NR 809.563 (2), Table R, may not be less than 0.2 mg/l for more than 4 hours.

(d) 1. The residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine, or chlorine dioxide, as specified in s. NR 809.563 (2), Table R, may not be undetectable in more than 5% of the samples each month, for any 2 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 s. NR 809.311 (1), Table F, 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% in one month for any 2 consecutive months.

$V = c + d + e/a + b \times 100$

where:

a = number of instances where the residual disinfectant con centration 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.

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

2. If the department determines, based on site specific considerations, that a public water system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions required in s. NR 809.311 (1), Table F, and that the system is providing adequate disinfection in the distribution system, the requirements of subd. 1. do not apply.

(2) DISINFECTION REQUIREMENTS FOR PUBLIC WATER SYSTEMS WHICH PROVIDE FILTRATION. Each public water system that provides filtration treatment shall provide disinfection treatment as follows:

(a) Disinfection treatment shall be sufficient to ensure that the total treatment processes of that system achieve at least 99.9% (3 log) inactivation or removal of *Giardia lamblia* cysts and at least 99.99% (4 log) inactivation or removal of viruses, as determined by the department.

(b) The residual disinfectant concentration in the water entering the distribution system, measured as specified in s. NR 809.563 (2), Table R, may not be less than 0.2 mg/l for more than 4 hours.

(c) 1. The residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine or chlorine dioxide, as specified in s. NR 809.563 (2), Table R, may not be undetectable in more than 5% of the samples each month, for any 2 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 s. NR 809.311 (1), Table F, is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement. Thus, the value "V" in the following formula may not exceed 5% in one month, for any 2 consecutive months.

V = c + d + e/a + b x 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.

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

2. If the department determines, based on site specific considerations, that a public water system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions required in s. NR 809.311 (1), Table F, and that the system is providing adequate disinfection in the distribution system, the requirements of subd. 1. do not apply.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.32 Disinfection profiling and benchmarking. (1) REQUIREMENTS WHEN MAKING A SIGNIFICANT CHANGE IN DISINFECTION PRACTICE. (a) Following the completion of initial source water monitoring under s. NR 809.331, the water supplier for a public water system that plans to make a significant change to its disinfection practice, as defined in par. (b), shall develop disinfection profiles and calculate disinfection benchmarks for *Giardia lamblia* and viruses as described in sub. (2). Prior to changing the disinfection practice, the water supplier shall notify the department and shall include in this notice all of the following information:

1. A completed disinfection profile and disinfection benchmark for *Giardia lamblia* and viruses as described in sub. (2).

2. A description of the proposed change in disinfection practice.

3. An analysis of how the proposed change will affect the current level of disinfection.

(b) Significant changes to disinfection practice are defined as any of the following:

1. Changes to the point of disinfection.

2. Changes to the disinfectants used in the treatment plant.

3. Changes to the disinfection process.

4. Any other modification identified by the department as a significant change to disinfection practice. Additional barriers with no change to existing disinfection practices may be exempt from these requirements.

(2) DEVELOPING THE DISINFECTION PROFILE AND BENCHMARK. Water suppliers for public water systems required to develop disinfection profiles under sub. (1) shall follow the requirements of this subsection:

(a) Water suppliers shall monitor at least weekly for a period of 12 consecutive months to determine the total logs of inactivation for *Giardia lamblia* and viruses. If water suppliers monitor more frequently, the monitoring frequency shall be evenly spaced. Systems that operate for fewer than 12 months per year shall be monitored weekly during the period of operation. Water suppliers shall determine log inactivation for *Giardia lamblia* through the entire plant, based on the $CT_{99.9}$ (3 log) values in ss. NR 810.47 to 810.62. Water suppliers shall determine log inactivation for viruses through the entire treatment plant based on a protocol approved by the department.

(b) Water suppliers for systems with a single point of disinfectant application prior to entrance to the distribution system shall conduct the monitoring in subds. 1. to 4. Water suppliers for systems with more than one point of disinfectant application shall conduct the monitoring in subds. 1. to 4. for each disinfection segment. Water suppliers shall monitor the parameters necessary to determine the total inactivation ratio, using analytical methods in s. NR 809.563 (2), Table R.

1. For systems using a disinfectant other than UV, the temperature of the disinfected water shall be measured at each residual disinfectant concentration sampling point during peak hourly flow.

2. For systems using chlorine, the pH of the disinfected water shall be measured at each chlorine residual disinfectant concentration sampling point during peak hourly flow.

3. The disinfectant contact times ("T") shall be determined during peak hourly flow.

4. The residual disinfectant concentrations ("C") of the water before or at the first customer and prior to each additional point of disinfection shall be measured during peak hourly flow.

(c) In lieu of conducting new monitoring under par. (b), public water systems may elect to meet the following requirements:

1. Water suppliers for systems that have at least one year of existing data that are substantially equivalent to data collected under par. (b) may use these data to develop disinfection profiles as specified in this section if the water system has neither made a significant change to its treatment practice nor changed sources since the data were collected. Water suppliers may develop disinfection profiles using up to 3 years of existing data.

2. Water suppliers may use disinfection profile or profiles developed previously in lieu of developing a new profile if the water system has not made a significant change, as determined under sub. (1) (b), to its treatment practice or has not changed sources since the profile was developed. Water suppliers for systems that have not developed a virus profile shall develop a virus profile using the same monitoring data on which the *Giardia lamblia* profile is based.

(d) The water supplier shall calculate the total inactivation ratio for *Giardia lamblia* as follows:

1. For water systems using only one point of disinfectant application, the water supplier may determine the total inactivation ratio for the disinfection segment based on either of the following methods:

a. Determine one inactivation ratio ($CT_{calc}/CT_{99.9}$) before or at the first customer during peak hourly flow.

b. Determine successive ($CT_{calc}/CT_{99.9}$) values, representing sequential inactivation ratios, between the point of disinfectant application and a point before or at the first customer during peak hourly flow. Under this alternative, the water supplier shall calculate the total inactivation ratio by determining ($CT_{calc}/CT_{99.9}$) for each sequence and then adding the ($CT_{calc}/CT_{99.9}$) values together to determine (Σ ($CT_{calc}/CT_{99.9}$)).

2. For systems using more than one point of disinfectant application before the first customer the water supplier shall determine the CT value of each disinfection segment immediately prior to the next point of disinfectant application, or for the final segment, before or at the first customer, during peak hourly flow. The ($CT_{calc}/CT_{99.9}$) value of each segment and (Σ ($CT_{calc}/CT_{99.9}$)) shall be calculated using the method in subd. 1.

3. The water supplier shall determine the total logs of inactivation by multiplying the value calculated in subd. 1. or 2. by 3.0.

(e) Water suppliers shall determine the total logs of inactivation for viruses using a protocol approved by the department.

(f) For water systems required to calculate a disinfection benchmark water suppliers shall use the following procedure:

1. For each year of profiling data collected and calculated under this subsection, the water supplier shall determine the lowest mean monthly level of both *Giardia lamblia* and virus inactivation. The water supplier shall determine the mean *Giardia lamblia* and virus inactivation for each calendar month for each year of profiling data by dividing the sum of daily or weekly *Giardia lamblia* and virus log inactivation by the number of values calculated for that month.

2. The disinfection benchmark is the lowest monthly mean value, for water systems with one year of profiling data, or the mean of lowest monthly mean values, for water systems with more than one year of profiling data, of the monthly logs of *Giardia lamblia* and virus log inactivation in each year of profiling data.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.33 Enhanced treatment requirements for *Cryptosporidium*. (1) APPLICABILITY. The requirements of this section apply to all public water systems supplied by a surface water source and public water systems supplied by a groundwater source under the direct influence of surface water.

(a) Wholesale systems shall comply with the requirements of this section based on the population of the largest system in the combined distribution system.

(b) The requirements of this section for filtered systems apply to water systems required by s. NR 810.29 to provide filtration treatment, whether or not the system is currently operating a filtration system.

(c) The requirements of this section for unfiltered groundwater systems under the direct influence of surface water apply only to unfiltered systems that timely met and continue to meet the filtration avoidance criteria in s. NR 810.30.

(2) REQUIREMENTS. Public water systems shall comply with the following requirements:

(a) Water suppliers shall conduct an initial and a second round of source water monitoring for each plant that treats a surface water or GWUDI source. This monitoring may include sampling for *Cryptosporidium*, E. coli, and turbidity as described in s. NR 809.331, to determine what level, if any, of additional *Cryptosporidium* treatment they shall provide.

(b) Water suppliers for systems that plan to make a significant change to their disinfection practice shall develop disinfection profiles and calculate disinfection benchmarks, as described in s. NR 810.32.

(c) Water suppliers for filtered systems shall determine their *Cryptosporidium* treatment bin classification as described in s. NR 810.34 and provide additional treatment for *Cryptosporidium*, if required, as described in s. NR 810.35. All unfiltered GWUDI systems shall provide treatment for *Cryptosporidium* as described in s. NR 810.36. Filtered systems and unfiltered GWUDI systems shall implement *Cryptosporidium* treatment according to the schedule in s. NR 810.37.

(d) Water systems with uncovered finished water storage facilities shall comply with the requirements to cover the facility as described in s. NR 810.28. Finished water is that water which has received all required treatment.

(e) Water systems required to provide additional treatment for *Cryptosporidium* shall implement microbial toolbox options that are designed and operated as described in ss. NR 810.41 to 810.46.

(f) Water suppliers for water systems shall comply with the applicable recordkeeping and reporting requirements described in ss. NR 810.39 and 810.40.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.34 *Cryptosporidium* bin classification for filtered systems. (1) Following completion of the initial round of source water monitoring required under s. NR 809.331 (1), water suppliers for filtered systems shall calculate an initial *Cryptosporidium* bin concentration for each plant for which monitoring was required. Calculation of the bin concentration shall use the *Cryptosporidium* results reported under s. NR 809.331 (1) and shall follow the procedures in sub. (2) (a) to (e).

(2) (a) For filtered systems that collect a total of at least 48 samples, the bin concentration is equal to the arithmetic mean of all sample concentrations.

(b) For filtered systems that collect a total of at least 24 samples, but not more than 47 samples, the bin concentration is equal to the highest arithmetic mean of all sample concentrations in any 12 consecutive months during which *Cryptosporidium* samples were collected.

(c) For filtered systems that serve fewer than 10,000 people and monitor for *Cryptosporidium* for only one year, collecting 24 samples in 12 months, the bin concentration is equal to the arithmetic mean of all sample concentrations.

(d) For filtered systems with plants operating only part of the year that monitor fewer than 12 months per year under s. NR 809.331 (5), the bin concentration is equal to the highest arithmetic mean of all sample concentrations during any year of *Cryptosporidium* monitoring.

(e) If the monthly *Cryptosporidium* sampling frequency varies, water suppliers shall first calculate a monthly average for each month of monitoring. Systems shall then use these monthly average concentrations, rather than individual sample concentrations, in the applicable calculation for bin classification in pars. (a) to (d).

(3) Water suppliers for filtered systems shall determine their initial bin classification from the following table and using the *Cryptosporidium* bin concentration calculated under subs. (1) and (2):

Bin Classification Table for Filtered Systems

For systems that are:	With a *Cryptosporidium* bin concentration of: [1]	The bin classification is:
Required to monitor for *Cryptosporidium* under s. NR 809.331	Cryptosporidium <0.075 oocyst/L	Bin 1
	0.075 oocysts/L $\leq$ *Cryptosporidium* <1.0 oocysts/L	Bin 2
	1.0 oocysts/L $\leq$ *Cryptosporidium* <3.0 oocysts/L	Bin 3
	Cryptosporidium $\geq$ 3.0 oocysts/L	Bin 4
Serving fewer than 10,000 people and NOT required to monitor for *Cryptosporidium* under s. NR 809.331 (1) (d)	NA	Bin 1

[1]Based on calculations in sub. (1) or (4), as applicable.

(4) Following completion of the second round of source water monitoring required under s. NR 809.331 (2), water suppliers for filtered systems shall recalculate their *Cryptosporidium* bin concentration using the *Cryptosporidium* results reported under s. NR 809.331 (2) and following the procedures in sub. (2) (a) to (d). Systems shall then redetermine their bin classification using this bin concentration and the table in sub. (3).

(5) Water suppliers shall report their bin classification of the water system as follows:

(a) Water suppliers for filtered systems shall report the initial bin classification under par. (c) to the department for approval no later than 6 months after the system is required to complete initial source water monitoring based on the schedule in s. NR 809.331 (3).

(b) Water suppliers for filtered systems shall report the bin classification under sub. (4) to the department for approval no later than 6 months after the system is required to complete the second round of source water monitoring based on the schedule in s. NR 809.331 (3).

(c) The bin classification report to the department shall include a summary of source water monitoring data and the calculation procedure used to determine bin classification.

(6) Failure to comply with the conditions of sub. (5) is a violation of the treatment technique requirement.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.35 *Cryptosporidium* treatment requirements for filtered systems. (1) Filtered systems shall provide the level of additional treatment for *Cryptosporidium* specified in this paragraph based on their bin classification as determined under s. NR 810.34 and according to the schedule in s. NR 810.37.

(2) Systems shall use the following treatment or management practices:

(a) Filtered systems shall use one or more of the treatment and management options listed in s. NR 810.41, termed the microbial toolbox, to comply with the additional *Cryptosporidium* treatment required in sub. (1).

(b) Filtered systems classified in Bin 3 and Bin 4 shall achieve at least 1−log of the additional *Cryptosporidium* treatment required under sub. (1) using either one or a combination of the following: bag filters, bank filtration, cartridge filters, chlorine dioxide, membranes, ozone, or UV, as described in ss. NR 810.42 to 810.46.

(3) Failure by a filtered system in any month to achieve treatment credit by meeting criteria in ss. NR 810.41 to 810.46 for microbial toolbox options that is at least equal to the level of treatment required in sub. (1) is a violation of the treatment technique requirement.

(4) If the department determines during a sanitary survey or an equivalent source water assessment that after a filtered system completed the monitoring conducted under s. NR 809.331 (1) or 809.331 (2), significant changes occurred in the system's watershed that could lead to increased contamination of the source water by *Cryptosporidium*, the system shall take actions specified by the department to address the contamination. These actions may include additional source water monitoring or implementing microbial toolbox options listed in s. NR 810.41, or both.

If the system bin classification is:	And the system uses the following filtration treatment in full compliance with s. NR 810.29 (as applicable), then the additional *Cryptosporidium* treatment requirements are:			
	Conventional filtration treatment (including softening)	Direct filtration	Slow sand or diatomaceous earth filtration	Alternative filtration technologies including membrane filtration
Bin 1	No additional treatment	No additional treatment	No additional treatment	No additional treatment.
Bin 2	1−log treatment	1.5−log treatment	1−log treatment	As determined by the department such that the total *Cryptosporidium* removal and inactivation is at least 4.0−log.
Bin 3	2−log treatment	2.5−log treatment	2−log treatment	As determined by the department such that the total *Cryptosporidium* removal and inactivation is at least 5.0−log.
Bin 4	2.5−log treatment	3−log treatment	2.5−log treatment	As determined by the department such that the total *Cryptosporidium* removal and inactivation is at least 5.5−log.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

File inserted into Admin. Code 2−1−2012. May not be current beginning 1 month after insert date. For current adm. code see:
http://docs.legis.wisconsin.gov/code/admin_code

NR 810.36 *Cryptosporidium* treatment requirements for groundwater under the direct influence of surface water systems that do not filter. Section NR 811.42 requires filtration for all surface water sources. The following applies only to GWUDI systems not required to filter.

(1) DETERMINATION OF MEAN *CRYPTOSPORIDIUM* LEVEL. (a) Following completion of the initial source water monitoring required under s. NR 809.331 (1), water suppliers for unfiltered systems shall calculate the arithmetic mean of all *Cryptosporidium* sample concentrations reported under s. NR 809.331 (1). Water suppliers shall report this value to the department for approval no later than 6 months after the month the system is required to complete initial source water monitoring based on the schedule in s. NR 809.331 (3).

(b) Following completion of the second round of source water monitoring required under s. NR 809.331 (2), water suppliers for unfiltered systems shall calculate the arithmetic mean of all *Cryptosporidium* sample concentrations reported under s. NR 809.331 (2). Water suppliers shall report this value to the department for approval no later than 6 months after the month the system is required to complete the second round of source water monitoring based on the schedule in s. NR 809.331 (3).

(c) If the monthly *Cryptosporidium* sampling frequency varies, water suppliers shall first calculate a monthly average for each month of monitoring. Systems shall then use these monthly average concentrations, rather than individual sample concentrations, in the calculation of the mean *Cryptosporidium* level in par. (a) or (b).

(d) The report to the department of the mean *Cryptosporidium* levels calculated under pars. (a) and (b) shall include a summary of the source water monitoring data used for the calculation.

(e) Failure to comply with the conditions of this subsection is a violation of the treatment technique requirement.

(2) CRYPTOSPORIDIUM INACTIVATION REQUIREMENTS. Unfiltered systems shall provide the level of inactivation for *Cryptosporidium* specified in this subsection, based on their mean *Cryptosporidium* levels as determined under sub. (1) and according to the schedule in s. NR 810.37.

(a) Unfiltered systems with a mean *Cryptosporidium* level of 0.01 oocysts/L or less shall provide at least 2−log *Cryptosporidium* inactivation.

(b) Unfiltered systems with a mean *Cryptosporidium* level of greater than 0.01 oocysts/L shall provide at least 3−log *Cryptosporidium* inactivation.

(3) INACTIVATION TREATMENT TECHNOLOGY REQUIREMENTS. Unfiltered systems shall use chlorine dioxide, ozone, or UV as described in s. NR 810.46 to meet the *Cryptosporidium* inactivation requirements of this section.

(a) Unfiltered systems that use chlorine dioxide or ozone and fail to achieve the *Cryptosporidium* inactivation required in sub. (2) on more than one day in the calendar month are in violation of the treatment technique requirement.

(b) Unfiltered systems that use UV light and fail to achieve the *Cryptosporidium* inactivation required in sub. (2) by meeting the criteria in s. NR 810.46 are in violation of the treatment technique requirement.

(4) USE OF TWO DISINFECTANTS. Unfiltered systems shall use a minimum of 2 disinfectants to meet the combined *Cryptosporidium* inactivation requirements of this section along with the *Giardia lamblia* and virus inactivation requirements of s. NR 810.31 (1). Each of the 2 disinfectants shall separately achieve the total inactivation required for either *Cryptosporidium*, *Giardia lamblia*, or viruses.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.37 *Cryptosporidium* treatment requirement compliance schedule. (1) Following initial bin classification under s. NR 810.34 (3), filtered systems shall provide the level of treatment for *Cryptosporidium* required under s. NR 810.35 according to the schedule in sub. (3).

(2) Following initial determination of the mean *Cryptosporidium* level under s. NR 810.36 (1) (a), unfiltered systems shall provide the level of treatment for *Cryptosporidium* required under s. NR 810.36 according to the schedule in sub. (3).

(3) Cryptosporidium treatment compliance dates.

Cryptosporidium Treatment Compliance Dates Table

Systems that serve...	Shall comply with *Cryptosporidium* treatment requirements no later than...[1]
At least 100,000 people	April 1, 2012.
From 50,000 to 99,999 people	October 1, 2012.
From 10,000 to 49,999 people	October 1, 2013.
Fewer than 10,000 people	October 1, 2014.

[1]The department may allow up to an additional 2 years for complying with the treatment requirement for systems making capital improvements.

(4) If the bin classification for a filtered system changes following the second round of source water monitoring, as determined under s. NR 810.34, the system shall provide the level of treatment for *Cryptosporidium* required under s. NR 810.35 on a schedule approved by the department.

(5) If the mean *Cryptosporidium* level for an unfiltered GWUDI system changes following the second round of monitoring, as determined under s. NR 810.36, and if the system is required to provide a different level of *Cryptosporidium* treatment under s. NR 810.36 due to this change, the system shall meet this treatment requirement on a schedule approved by the department.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.38 Monitoring requirements. (1) MONITORING REQUIREMENTS FOR GROUNDWATER SYSTEMS UNDER THE DIRECT INFLUENCE OF SURFACE WATER THAT DO NOT PROVIDE FILTRATION. A public water system that uses a groundwater source under the direct influence of surface water and does not provide filtration treatment shall begin monitoring as specified in this subsection on December 31, 1990, or 6 months after the department determines that the groundwater source is under the direct influence of surface water, whichever is later.

(a) Fecal coliform or total coliform density measurements as required by s. NR 810.30 (1) (a) shall be performed on representative source water samples immediately prior to the first or only point of disinfectant application. The water supplier shall 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
≤500	1
501 to 3,300	2
3,301 to 10,000	3
10,001 to 25,000	4
>25,000	5

(b) The samples in par. (a) shall be taken on separate days. In addition, one fecal or total coliform density measurement shall be performed every day the system serves water to the public and the turbidity of the source water exceeds one NTU. These samples count toward the weekly coliform sampling requirement.

(c) Turbidity measurements as required by s. NR 810.30 (1) (b) shall be performed on representative grab samples of source water immediately prior to the first or only point of disinfectant application every 4 hours, or more frequently, that the system serves water to the public. A public water system may substitute continu-

ous turbidity monitoring for grab sample monitoring if it validates the continuous measurement for accuracy on a regular basis using a protocol approved by the department.

(d) The total inactivation ratio for each day that the system is in operation shall be determined based on the CT values in ss. NR 810.47 to 810.62, as appropriate. The parameters necessary to determine the total inactivation ratio shall be monitored as follows:

1. Temperature of the disinfected water shall be measured at least once per day at each residual disinfectant concentration sampling point.

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

3. The disinfectant contact time ("T") shall be determined for each day during peak hourly flow.

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

5. If a system uses a disinfectant other than chlorine, the water supplier may demonstrate to the department, through the use of a department approved protocol for on−site disinfection challenge studies or other information satisfactory to the department, that CT values other than those specified in ss. NR 810.54 to 810.62, and other operational parameters, are adequate to demonstrate that the system is achieving the minimum inactivation rates specified in s. NR 810.31 (1) (a).

(e) For any given disinfectant, the total inactivation ratio shall be calculated as follows:

1. If the system uses only one point of disinfectant application, the water supplier may determine the total inactivation ratio based on either of the following 2 methods:

a. One inactivation ratio ($CT_{calc}/CT_{99.9}$) is determined before or at the first customer during peak hourly flow and if the ($CT_{calc}/CT_{99.9}$) is greater than or equal to 1.0, the 99.9% *Giardia lamblia* inactivation requirement has been achieved.

b. Successive ($CT_{calc}/CT_{99.9}$) 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 shall be used to calculate the total inactivation ratio:

Determine ($CT_{calc}/CT_{99.9}$) for each sequence.

Add the ($CT_{calc}/CT_{99.9}$) values together $\Sigma(CT_{calc}/CT_{99.9})$.

If Σ ($CT_{calc}/CT_{99.9}$) > or = 1.0, the 99.9% *Giardia lamblia* inactivation requirement has been achieved.

2. If the system uses more than one point of disinfectant application before or at the first customer, the water supplier shall determine the CT value of each disinfection sequence immediately prior to the next point of disinfectant application during peak flow. The ($CT_{calc}/CT_{99.9}$) value of each sequence and Σ ($CT_{calc}/CT_{99.9}$) shall be calculated using the method in subd. 1. b. to determine if the system is in compliance with s. NR 810.31.

3. 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:

Percent inactivation = 100 − (100/10), where

z = 3 x summation of ($CT_{calc}/CT_{99.9}$)

(f) The residual disinfectant concentration of the water entering the distribution system shall be monitored continuously, and the lowest value shall 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 following prescribed frequencies:

System Size by Population	Samples/day
≤500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

(g) The day's samples to meet par. (f) cannot be taken at the same time. The sampling intervals are subject to department 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 water supplier for the system shall take a grab sample every 4 hours until the residual concentration is equal to or greater than 0.2 mg/l.

(h) The residual disinfectant concentration of the water in the distribution system shall be measured as follows:

1. The residual disinfectant concentration shall be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled, except that the department may allow the water supplier for a public water system which uses a groundwater source, to take disinfectant residual samples at points other than the total coliform sampling points if the department determines that the points are more representative of treated (disinfected) water quality within the distribution system. Heterotrophic bacteria, measured as heterotrophic plate count (HPC) as specified in s. NR 809.311 (1), Table F, may be measured in lieu of residual disinfectant concentration, when approved by the department.

2. If the department 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 s. NR 809.311, Table F, and that the system is providing adequate disinfection in the distribution system, the requirements of subd. 1. do not apply to that system.

(2) MONITORING REQUIREMENTS FOR SYSTEMS USING FILTRATION TREATMENT. Water suppliers for a public water system that uses a surface water source or a groundwater source under the direct influence of surface water and provides filtration treatment shall monitor in accordance with all of the following:

(a) Turbidity measurements as specified in s. NR 810.29 shall be performed on representative samples of the system's combined filter effluent water every 4 hours, or more frequently, that the system serves water to the public. A water supplier 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 department. For any systems using slow sand filtration or filtration treatment other than conventional filtration treatment, direct filtration or diatomaceous earth filtration, the department 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 department may reduce the turbidity sampling frequency to once per day, regardless of the type of filtration treatment used, if the department determines that less frequent monitoring is sufficient to indicate effective filtration performance.

(b) Water suppliers for systems using conventional filtration treatment or direct filtration shall conduct continuous monitoring of turbidity for each individual filter using a method approved in s. NR 809.113 (1), Tables A and B and shall calibrate turbidimeters using the procedure specified by the manufacturer. Water suppliers shall record the results of individual filter monitoring every 15 minutes. If there is a failure in the continuous monitoring equipment, the water supplier shall conduct grab sampling every 4 hours in lieu of continuous monitoring, until the turbidimeter is repaired and back on−line. The water supplier shall repair the equipment no later than 5 working days after the failure or the system is in violation.

File inserted into Admin. Code 2−1−2012. May not be current beginning 1 month after insert date. For current adm. code see:
http://docs.legis.wisconsin.gov/code/admin_code

(c) The residual disinfectant concentration of the water entering the distribution system shall be monitored continuously, and the lowest value shall 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. Water suppliers for 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 as follows:

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 department 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 water supplier shall take a grab sample every 4 hours until the residual disinfectant concentration is equal to or greater than 0.2 mg/l.

(d) The residual disinfectant concentration in the distribution system shall be measured as follows:

1. The residual disinfectant concentration shall be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled. The department may allow a public water system which uses both a surface water source or a groundwater source under direct influence of surface water, and a groundwater source to take disinfectant residual samples at points other than the total coliform sampling points if the department determines that the points are more representative of treated or disinfected water quality within the distribution system. Heterotrophic bacteria, measured as heterotrophic plate count (HPC) as specified in s. NR 809.311 (1), Table F, may be measured in lieu of residual disinfectant concentration, when approved by the department.

2. If the department 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 s. NR 809.311 (1), Table F, and that the system is providing adequate disinfection in the distribution system, the requirements of subd. 1. do not apply to that system.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.39 Reporting requirements. (1) Water suppliers shall report sampling schedules under s. NR 809.332 and source water monitoring results under s. NR 809.336 to the department unless they notify the department that they will not conduct source water monitoring due to meeting the criteria of s. NR 809.331 (4).

(2) Water suppliers for filtered systems shall report the *Cryptosporidium* bin classification of their system to the department as described in s. NR 810.34.

(3) Water suppliers for unfiltered GWUDI systems shall report the mean source water *Cryptosporidium* level of their system to the department as described in s. NR 810.36.

(4) Water suppliers for filtered and unfiltered systems shall report disinfection profiles and benchmarks to the department as described in s. NR 810.32 prior to making a significant change in disinfection practice.

(5) Water suppliers for filtered and unfiltered systems shall report to the department in accordance with the following table for any microbial toolbox options used to comply with treatment requirements under s. NR 810.35 or 810.36. Alternatively, the department may approve a system to certify operation within required parameters for treatment credit rather than reporting monthly operational data for toolbox options.

Microbial Toolbox Reporting Requirements

Toolbox option	Systems shall submit the following information	On the following schedule
(1) Watershed control program (WCP)	(a) Notice of intention to develop a new or continue an existing watershed control program.	No later than 2 years before the applicable treatment compliance date in s. NR 810.37.
	(b) Watershed control plan.	No later than one year before the applicable treatment compliance date in s. NR 810.37.
	(c) Annual watershed control program status report.	Every 12 months, beginning one year after the applicable treatment compliance date in s. NR 810.37.
	(d) Watershed sanitary survey report.	For community water systems, every 3 years beginning 3 years after the applicable treatment compliance date in s. NR 810.37. For noncommunity water systems, every 5 years beginning 5 years after the applicable treatment compliance date in s. NR 810.37.
(2) Alternative source/intake management	Verification that system has relocated the intake or adopted the intake withdrawal procedure reflected in monitoring results.	No later than the applicable treatment compliance date in s. NR 810.37.

Toolbox option	Systems shall submit the following information	On the following schedule
(3) Presedimentation	Monthly verification of the following: (a) Continuous basin operation (b) Treatment of 100% of the flow (c) Continuous addition of a coagulant (d) At least 0.5−log mean reduction of influent turbidity or compliance with alternative department−approved performance criteria.	Monthly reporting within 10 days following the month in which the monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(4) Two−stage lime softening	Monthly verification of the following: (a) Chemical addition and hardness precipitation occurred in 2 separate and sequential softening stages prior to filtration (b) Both stages treated 100% of the plant flow.	Monthly reporting within 10 days following the month in which the monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(5) Bank filtration	(a) Initial demonstration of the following: 1. Unconsolidated, predominantly sandy aquifer 2. Setback distance of at least 25 ft. (0.5−log credit) or 50 ft. (1.0−log credit).	No later than the applicable treatment compliance date in s. NR 810.37.
	(b) If monthly average of daily max turbidity is greater than one NTU then system shall report result and submit an assessment of the cause.	Report within 30 days following the month in which the monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(6) Combined filter performance	Monthly verification of combined filter effluent (CFE) turbidity levels less than or equal to 0.15 NTU in at least 95% of the 4 hour CFE measurements taken each month.	Monthly reporting within 10 days following the month in which the monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(7) Individual filter performance	Monthly verification of the following: (a) Individual filter effluent (IFE) turbidity levels less than or equal to 0.15 NTU in at least 95% of samples each month in each filter (b) No individual filter greater than 0.3 NTU in 2 consecutive readings 15 minutes apart.	Monthly reporting within 10 days following the month in which the monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(8) Demonstration of performance	(a) Results from testing following a department approved protocol. (b) As required by the department, monthly verification of operation within conditions of department approval for demonstration of performance credit.	(a) No later than the applicable treatment compliance date in s. NR 810.37. (b) Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(9) Bag filters and cartridge filters	(a) Demonstration that the following criteria are met: 1. Process meets the definition of bag or cartridge filtration; 2. Removal efficiency established through challenge testing that meets criteria in this chapter.	No later than the applicable treatment compliance date in s. NR 810.37.
	(b) Monthly verification that 100% of plant flow was filtered.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(10) Membrane filtration	(a) Results of verification testing demonstrating the following: 1. Removal efficiency established through challenge testing that meets criteria in this chapter; 2. Integrity test method and parameters, including resolution, sensitivity, test frequency, control limits, and associated baseline.	No later than the applicable treatment compliance date in s. NR 810.37.
	(b) Monthly report summarizing the following: 1. All direct integrity tests above the control limit; 2. If applicable, any turbidity or alternative department−approved indirect integrity monitoring results triggering direct integrity testing and the corrective action that was taken.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(11) Second stage filtration	Monthly verification that 100% of flow was filtered through both stages and that first stage was preceded by coagulation step.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(12) Slow sand filtration (as secondary filter)	Monthly verification that both a slow sand filter and a preceding separate stage of filtration treated 100% of flow from surface water sources.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.

Toolbox option	Systems shall submit the following information	On the following schedule
(13) Chlorine dioxide	Summary of CT values for each day as described in s. NR 810.46.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(14) Ozone	Summary of CT values for each day as described in s. NR 810.46.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.
(15) UV	(a) Validation test results demonstrating operating conditions that achieve required UV dose.	No later than the applicable treatment compliance date in s. NR 810.37.
	(b) Monthly report summarizing the percentage of water entering the distribution system that was not treated by UV reactors operating within validated conditions for the required dose as specified in s. NR 810.46.	Within 10 days following the month in which monitoring was conducted, beginning on the applicable treatment compliance date in s. NR 810.37.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.40 Recordkeeping requirements. (1) Public water systems shall keep results from the initial round of source water monitoring under s. NR 809.331 (1) and the second round of source water monitoring under s. NR 809.331 (2) until 3 years after bin classification under s. NR 810.34 for filtered systems or determination of the mean *Cryptosporidium* level under s. NR 810.35 for unfiltered GWUDI systems for the particular round of monitoring.

(2) Public water systems shall keep any notification to the department that the systems will not conduct source water monitoring due to meeting the criteria of s. NR 809.331 (4) for 3 years from the date of notification.

(3) Public water systems shall keep the results of treatment monitoring associated with microbial toolbox options under ss. NR 810.42 to 810.46 for 3 years from the date of monitoring.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

Subchapter III — Toolbox Options for Meeting Enhanced Treatment for *Cryptosporidium* Requirements

NR 810.41 Microbial toolbox options. (1) (a) Public water systems receive the treatment credits listed in the table in sub. (2) by meeting the conditions for microbial toolbox options described in ss. NR 810.42 to 810.46. Systems apply these treatment credits to meet the treatment requirements in s. NR 810.35 or 810.36, as applicable.

(b) Unfiltered GWUDI systems are eligible for treatment credits for the microbial toolbox options described in s. NR 810.46 only.

(2) The following table summarizes options in the microbial toolbox:

Microbial Toolbox Summary Table: Options, Treatment Credits, and Criteria

Toolbox Option	*Cryptosporidium* treatment credit with design and implementation criteria
Source Protection and Management Toolbox Options	
(1) Watershed control program	0.5−log credit for department−approved program comprising required elements, annual program status report to department, and regular watershed survey. Unfiltered systems are not eligible for credit. Specific criteria are in s. NR 810.42 (1).
(2) Alternative source/ intake management	No prescribed credit. Systems may conduct simultaneous monitoring for treatment bin classification at alternative intake locations or under alternative intake management strategies. Specific criteria are in s. NR 810.42 (2).
Pre Filtration Toolbox Options	
(3) Presedimentation basin with coagulation	0.5−log credit during any month that presedimentation basins achieve a monthly mean reduction of 0.5−log or greater in turbidity or alternative department−approved performance criteria. To be eligible, basins shall be operated continuously with coagulant addition and all plant flow shall pass through basins. Specific criteria are in s. NR 810.43 (1).
(4) Two−stage lime softening	0.5−log credit for 2−stage softening where chemical addition and hardness precipitation occur in both stages. All plant flow shall pass through both stages. Single−stage softening is credited as equivalent to conventional treatment. Specific criteria are in s. NR 810.43 (2).
(5) Bank filtration	0.5−log credit for 25−foot setback; 1.0−log credit for 50−foot setback; aquifer shall be unconsolidated sand containing at least 10% fines; average turbidity in wells shall be less than one NTU. Systems using wells followed by filtration when conducting source water monitoring shall sample the well to determine bin classification and are not eligible for additional credit. Specific criteria are in s. NR 810.43 (3).
Treatment Performance Toolbox Options	
(6) Combined filter performance	0.5−log credit for combined filter effluent turbidity less than or equal to 0.15 NTU in at least 95% of measurements each month. Specific criteria are in s. NR 810.44 (1).

(7) Individual filter performance	0.5−log credit, in addition to 0.5−log combined filter performance credit, if individual filter effluent turbidity is less than or equal to 0.15 NTU in at least 95% of samples each month in each filter and is never greater than 0.3 NTU in 2 consecutive measurements in any filter. Specific criteria are in s. NR 810.44 (2).
(8) Demonstration of performance	Credit awarded to unit process or treatment train based on a demonstration to the department with a department−approved protocol. Specific criteria are in s. NR 810.44 (3).
Additional Filtration Toolbox Options	
(9) Bag or cartridge filters (individual filters)	Up to 2−log credit based on the removal efficiency demonstrated during challenge testing with a 1.0−log factor of safety. Specific criteria are in s. NR 810.45 (1).
(10) Bag or cartridge filters (in series)	Up to 2.5−log credit based on the removal efficiency demonstrated during challenge testing with a 0.5−log factor of safety. Specific criteria are in s. NR 810.45 (1).
(11) Membrane filtration	Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing. Specific criteria are in s. NR 810.45 (2).
(12) Second stage filtration	0.5−log credit for second separate granular media filtration stage if treatment train includes coagulation prior to first filter. Specific criteria are in s. NR 810.45 (3)
Toolbox Option	***Cryptosporidium* treatment credit with design and implementation criteria**
Additional Filtration Toolbox Options	
(13) Slow sand filters	2.5−log credit as a secondary filtration step; 3.0−log credit as a primary filtration process. No prior chlorination for either option. Specific criteria are in s. NR 810.45 (4).
Inactivation Toolbox Options	
(14) Chlorine dioxide	Log credit based on measured CT in relation to CT table. Specific criteria are in s. NR 810.46 (2)
(15) Ozone	Log credit based on measured CT in relation to CT table. Specific criteria are in s. NR 810.46 (2).
(16) UV	Log credit based on validated UV dose in relation to UV dose table; reactor validation testing required to establish UV dose and associated operating conditions. Specific criteria are in s. NR 810.46 (4).

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.42 Source toolbox components. (1) WATERSHED CONTROL PROGRAM. Systems receive 0.5−log *Cryptosporidium* treatment credit for implementing a watershed control program that meets the requirements of this section.

(a) Water suppliers for systems that intend to apply for the watershed control program credit shall notify the department of this intent no later than 2 years prior to the treatment compliance date applicable to the system in s. NR 810.37.

(b) Water suppliers for systems shall submit to the department a proposed watershed control plan no later than one year before the applicable treatment compliance date in s. NR 810.37. The department shall approve the watershed control plan for the system to receive watershed control program treatment credit. The watershed control plan shall include the following elements:

1. Identification of an "area of influence" outside of which the likelihood of *Cryptosporidium* or fecal contamination affecting the treatment plant intake is not significant. The area of influence is the area to be evaluated in future watershed surveys under subd. 2.

2. Identification of both potential and actual sources of *Cryptosporidium* contamination and an assessment of the relative impact of these sources on the system's source water quality.

3. An analysis of the effectiveness and feasibility of control measures that could reduce *Cryptosporidium* loading from sources of contamination to the system's source water.

4. A statement of goals and specific actions the system will undertake to reduce source water *Cryptosporidium* levels. The plan shall explain how the actions are expected to contribute to specific goals, identify watershed partners and their roles, identify resource requirements and commitments, and include a schedule for plan implementation with deadlines for completing specific actions identified in the plan.

(c) Public water systems with existing watershed control programs in place on or before January 5, 2006, are eligible to seek this credit. The watershed control plans shall meet the criteria in par. (b) and shall specify ongoing and future actions that will reduce source water *Cryptosporidium* levels.

(d) If the department does not respond to a water supplier regarding approval of a watershed control plan submitted under this section and the system meets the other requirements of this section, the watershed control program will be considered approved and 0.5 log *Cryptosporidium* treatment credit will be awarded unless and until the department subsequently withdraws the approval.

(e) Systems shall complete the following actions to maintain the 0.5−log credit:

1. Submit an annual watershed control program status report to the department. The annual watershed control program status report shall describe the system's implementation of the approved plan and assess the adequacy of the plan to meet its goals. The status report shall explain how the system is addressing any shortcomings in plan implementation, including those previously identified by the department or as the result of the watershed survey conducted under subd. 2. It shall also describe any significant changes that have occurred in the watershed since the last watershed sanitary survey. If a system determines during implementation that making a significant change to its approved watershed control program is necessary, the water supplier shall notify the department prior to making any changes. If any change is likely to reduce the level of source water protection, the water supplier shall also list in this notification the actions the system will take to mitigate this effect.

2. Undergo a watershed sanitary survey every 3 years for community water systems and every 5 years for noncommunity water systems and submit the survey report to the department. The survey shall be conducted according to department guidelines and by persons the department approves.

a. The watershed sanitary survey shall meet the following criteria: encompass the region identified in the department−approved watershed control plan as the area of influence; assess the implementation of actions to reduce source water *Cryptosporidium* levels; and identify any significant new sources of *Cryptosporidium*.

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b. If the department determines that significant changes may have occurred in the watershed since the previous watershed sanitary survey, systems shall undergo another watershed sanitary survey by a date the department requires, which may be earlier than the regular date in this subdivision.

3. The water supplier for the system shall make the watershed control plan, annual status reports, and watershed sanitary survey reports available to the public upon request. These documents shall be in a plain language style and include criteria by which to evaluate the success of the program in achieving plan goals.

(f) If the department determines that a system is not complying with the approved watershed control plan, the department may withdraw the watershed control program treatment credit.

(2) ALTERNATIVE SOURCE. (a) A water supplier for a system may conduct source water monitoring that reflects a different intake location, either in the same source or for an alternate source, or a different procedure for the timing or level of withdrawal from the source (alternative source monitoring). If the department approves, a water supplier for that system may determine its bin classification under s. NR 810.34 based on the alternative source monitoring results.

(b) If water suppliers for systems conduct alternative source monitoring under this subsection, water suppliers shall also monitor the current plant intake for the system concurrently as described in s. NR 809.331.

(c) Alternative source monitoring under par. (a) shall meet the requirements for source monitoring to determine bin classification, as described in ss. NR 809.331 to 809.336. Water suppliers shall report the alternative source monitoring results to the department, along with supporting information documenting the operating conditions under which the samples were collected.

(d) If the water supplier for a system determines the system bin classification under s. NR 810.34 using alternative source monitoring results that reflect a different intake location or a different procedure for managing the timing or level of withdrawal from the source, the system shall relocate the intake or permanently adopt the withdrawal procedure, as applicable, no later than the applicable treatment compliance date in s. NR 810.37.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.43 Pre−filtration treatment toolbox components. (1) PRESEDIMENTATION. Systems receive 0.5−log *Cryptosporidium* treatment credit for a presedimentation basin during any month the process meets the criteria in this subsection.

(a) The presedimentation basin shall be in continuous operation and shall treat the entire plant flow taken from a surface water or GWUDI source.

(b) The system shall continuously add a coagulant to the presedimentation basin.

(c) The presedimentation basin shall achieve the following performance criteria:

1. Demonstrates at least 0.5−log mean reduction of influent turbidity. This reduction shall be determined using daily turbidity measurements in the presedimentation process influent and effluent and shall be calculated as follows: $\log_{10}$(monthly mean of daily influent turbidity)−$\log_{10}$(monthly mean of daily effluent turbidity).

2. Complies with department−approved performance criteria that demonstrate at least 0.5−log mean removal of micron−sized particulate material through the presedimentation process.

(2) TWO−STAGE LIME SOFTENING. Systems receive an additional 0.5−log *Cryptosporidium* treatment credit for a 2−stage lime softening plant if chemical addition and hardness precipitation occur in 2 separate and sequential softening stages prior to filtration. Both softening stages shall treat the entire plant flow taken from a surface water or GWUDI source.

(3) BANK FILTRATION. Systems receive *Cryptosporidium* treatment credit for bank filtration that serves as pretreatment to a filtration plant by meeting the criteria in this subsection. Systems using bank filtration when they begin source water monitoring under s. NR 809.331 (1) shall collect samples as described in s. NR 809.333 (4) and are not eligible for this credit.

(a) Wells with a groundwater flow path of at least 25 feet receive 0.5−log treatment credit; wells with a groundwater flow path of at least 50 feet receive 1.0−log treatment credit. The groundwater flow path shall be determined as specified in par. (d).

(b) Only wells in granular aquifers are eligible for treatment credit. Granular aquifers are those comprised of sand, clay, silt, rock fragments, pebbles or larger particles, and minor cement. A system shall characterize the aquifer at the well site to determine aquifer properties. Systems shall extract a core from the aquifer and demonstrate that in at least 90% of the core length, grains less than 1.0 mm in diameter constitute at least 10% of the core material.

(c) Only horizontal and vertical wells are eligible for treatment credit.

(d) For vertical wells, the groundwater flow path is the measured distance from the edge of the surface water body under high flow conditions, determined by the 100−year floodplain elevation boundary or by the floodway, as defined in federal emergency management agency flood hazard maps, to the well screen. For horizontal wells, the groundwater flow path is the measured distance from the bed of the river under normal flow conditions to the closest horizontal well lateral screen.

(e) The water supplier for the system shall monitor each wellhead for turbidity at least once every 4 hours while the bank filtration process is in operation. If monthly average turbidity levels, based on daily maximum values in the well, exceed one NTU, the water supplier for the system shall report this result to the department and conduct an assessment within 30 days to determine the cause of the high turbidity levels in the well. If the department determines that microbial removal has been compromised, the department may revoke treatment credit until the system implements corrective actions approved by the department to remediate the problem.

(f) Springs and infiltration galleries are not eligible for treatment credit under this section, but are eligible for credit under s. NR 810.44 (3).

(g) The department may approve *Cryptosporidium* treatment credit for bank filtration based on a demonstration of performance study that meets the criteria in this paragraph. This treatment credit may be greater than 1.0−log and may be awarded to bank filtration that does not meet the criteria in pars. (a) to (e).

1. The study shall follow a department−approved protocol and shall involve the collection of data on the removal of *Cryptosporidium* or a surrogate for *Cryptosporidium* and related hydrogeologic and water quality parameters during the full range of operating conditions.

2. The study shall include sampling both from the production well or wells and from monitoring wells that are screened and located along the shortest flow path between the surface water source and the production well or wells.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.44 Treatment performance toolbox components. (1) COMBINED FILTER PERFORMANCE. Public water systems using conventional filtration treatment or direct filtration treatment receive an additional 0.5−log *Cryptosporidium* treatment credit during any month the system meets the criteria in this subsection. Combined filter effluent (CFE) turbidity shall be less than or equal to 0.15 NTU in at least 95% of the measurements. Turbidity shall be measured as described in s. NR 809.113 (1), Tables A and B.

(2) INDIVIDUAL FILTER PERFORMANCE. Public water systems using conventional filtration treatment or direct filtration treatment receive 0.5−log *Cryptosporidium* treatment credit, which may be in addition to the 0.5−log credit under sub. (1), during any month the system meets the criteria in this subsection. Compliance with these criteria shall be based on individual filter turbidity monitoring as described in s. NR 809.113 (1) Tables A and B, as applicable.

(a) The filtered water turbidity for each individual filter shall be less than or equal to 0.15 NTU in at least 95% of the measurements recorded each month.

(b) No individual filter may have a measured turbidity greater than 0.3 NTU in 2 consecutive measurements taken 15 minutes apart.

(c) Any system that has received treatment credit for individual filter performance and fails to meet the requirements of par. (a) or (b) during any month does not receive a treatment technique violation under s. NR 810.35 (3) if the department determines the following:

1. The failure was due to unusual and short−term circumstances that could not reasonably be prevented through optimizing treatment plant design, operation, and maintenance.

2. The system has experienced no more than 2 such failures in any calendar year.

(3) DEMONSTRATION OF PERFORMANCE. The department may approve *Cryptosporidium* treatment credit for drinking water treatment processes based on a demonstration of performance study that meets the criteria in this subsection. This treatment credit may be greater than or less than the prescribed treatment credits in s. NR 810.35 or ss. NR 810.43 to 810.46 and may be awarded to treatment processes that do not meet the criteria for the prescribed credits.

(a) Systems cannot receive the prescribed treatment credit for any toolbox box option in ss. NR 810.43 to 810.46 if that toolbox option is included in a demonstration of performance study for which treatment credit is awarded under this subsection.

(b) The demonstration of performance study shall follow a department−approved protocol and shall demonstrate the level of *Cryptosporidium* reduction the treatment process will achieve under the full range of expected operating conditions for the system.

(c) Approval by the department shall be in writing and may include monitoring and treatment performance criteria that the water supplier for the system shall demonstrate and report on an ongoing basis to remain eligible for the treatment credit. The department may designate the criteria where necessary to verify that the conditions under which the demonstration of performance credit was approved are maintained during routine operation.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.45 Additional filtration toolbox components. (1) BAG OR CARTRIDGE FILTERS. Public water systems receive *Cryptosporidium* treatment credit of up to 2.0−log for individual bag or cartridge filters and up to 2.5−log for bag or cartridge filters operated in series by meeting the criteria in pars. (a) to (j). To be eligible for this credit, water suppliers for systems shall report the results of challenge testing that meets the requirements of pars. (b) to (i) to the department. The filters shall treat the entire plant flow taken from a surface water or GWUDI source.

(a) The *Cryptosporidium* treatment credit awarded to bag or cartridge filters shall be based on the removal efficiency demonstrated during challenge testing that is conducted according to the criteria in pars. (b) to (i). A factor of safety equal to 1−log for individual bag or cartridge filters and 0.5−log for bag or cartridge filters in series shall be applied to challenge testing results to determine removal credit. Systems may use results from challenge testing conducted prior to January 5, 2006 if the prior testing was consistent with the criteria specified in pars. (b) to (i).

(b) Challenge testing shall be performed on full−scale bag or cartridge filters, and the associated filter housing or pressure vessel, that are identical in material and construction to the filters and housings the system will use for removal of *Cryptosporidium*. Bag or cartridge filters shall be challenge tested in the same configuration that the system will use, either as individual filters or as a series configuration of filters.

(c) Challenge testing shall be conducted using *Cryptosporidium* or a surrogate that is removed no more efficiently than *Cryptosporidium*. The microorganism or surrogate used during challenge testing is referred to as the challenge particulate. The concentration of the challenge particulate shall be determined using a method capable of discreetly quantifying the specific microorganism or surrogate used in the test; gross measurements such as turbidity may not be used.

(d) The maximum feed water concentration that can be used during a challenge test shall be based on the detection limit of the challenge particulate in the filtrate, including filtrate detection limit, and shall be calculated using the following equation:

Maximum Feed Concentration = $1 \times 10^4 \times$ (Filtrate Detection Limit)

(e) Challenge testing shall be conducted at the maximum design flow rate for the filter as specified by the manufacturer.

(f) Each filter evaluated shall be tested for a duration sufficient to reach 100% of the terminal pressure drop, which establishes the maximum pressure drop under which the filter may be used to comply with the requirements of this chapter.

(g) Removal efficiency of a filter shall be determined from the results of the challenge test and expressed in terms of log removal values using the following equation:

$LRV = LOG_{10}(C_f) - LOG_{10}(C_p)$

Where:

LRV = log removal value demonstrated during challenge testing; C_f= the feed concentration measured during the challenge test; and C_p= the filtrate concentration measured during the challenge test. In applying this equation, the same units shall be used for the feed and filtrate concentrations. If the challenge particulate is not detected in the filtrate, then the term C_p shall be set equal to the detection limit.

(h) Each filter tested shall be challenged with the challenge particulate during 3 periods over the filtration cycle: within 2 hours of start−up of a new filter; when the pressure drop is between 45% and 55% of the terminal pressure drop; and at the end of the cycle after the pressure drop has reached 100% of the terminal pressure drop. An LRV shall be calculated for each of these challenge periods for each filter tested. The LRV for the filter (LRV_{filter}) shall be assigned the value of the minimum LRV observed during the 3 challenge periods for that filter.

(i) If fewer than 20 filters are tested, the overall removal efficiency for the filter product line shall be set equal to the lowest LRV_{filter} among the filters tested. If 20 or more filters are tested, the overall removal efficiency for the filter product line shall be set equal to the 10th percentile of the set of LRV_{filter} values for the various filters tested. The percentile is defined by (i/(n+1)) where i is the rank of n individual data points ordered lowest to highest. If necessary, the 10th percentile may be calculated using linear interpolation.

(j) If a previously tested filter is modified in a manner that could change the removal efficiency of the filter product line, challenge testing to demonstrate the removal efficiency of the modified filter shall be conducted and submitted to the department.

(2) MEMBRANE FILTRATION. (a) *Definitions*. In this subsection:

1. "Flux" means the throughput of a pressure driven membrane process expressed as flow per unit of membrane area.

2. "Module" means the smallest component of a membrane unit in which a specific membrane surface area is housed in a device with a filtrate outlet structure.

3. "Recovery" means the volumetric percent of feed water that is converted to filtrate over the course of an operating cycle uninterrupted by events such as chemical cleaning or a solids removal process such as backwashing.

(b) *Removal credit.* Systems receive *Cryptosporidium* treatment credit for membrane filtration that meets the criteria of this paragraph. Membrane cartridge filters that meet the definition of membrane filtration in s. NR 810.02 (27) are eligible for this credit. The level of treatment credit a system receives is equal to the lower of the values determined under the following:

1. The removal efficiency demonstrated during challenge testing conducted under the conditions in par. (b).

2. The maximum removal efficiency that can be verified through direct integrity testing used with the membrane filtration process under the conditions in par. (c).

(c) *Challenge testing*. The membrane used by the system shall undergo challenge testing to evaluate removal efficiency, and the water supplier for the system shall report the results of challenge testing to the department. Challenge testing shall be conducted according to the criteria in subds. 1 to 7. Systems may use data from challenge testing conducted prior to January 5, 2006, if the prior testing was consistent with the following criteria:

1. Challenge testing shall be conducted on either a full−scale membrane module, identical in material and construction to the membrane modules used in the system's treatment facility, or a smaller−scale membrane module, identical in material and similar in construction to the full−scale module.

2. Challenge testing shall be conducted using *Cryptosporidium* oocysts or a surrogate that is removed no more efficiently than *Cryptosporidium* oocysts. The organism or surrogate used during challenge testing is referred to as the challenge particulate. The concentration of the challenge particulate, in both the feed and filtrate water, shall be determined using a method capable of discretely quantifying the specific challenge particulate used in the test; gross measurements such as turbidity may not be used.

3. The maximum feed water concentration that may be used during a challenge test is based on the detection limit of the challenge particulate in the filtrate and shall be determined according to the following equation:

Maximum Feed Concentration = $3.16 \times 10^6 \times$ (Filtrate Detection Limit)

4. Challenge testing shall be conducted under representative hydraulic conditions at the maximum design flux and maximum design process recovery specified by the manufacturer for the membrane module.

5. Removal efficiency of a membrane module shall be calculated from the challenge test results and expressed as a log removal value according to the following equation:

$LRV = LOG_{10}(C_f) - LOG_{10}(C_p)$

Where:

LRV = log removal value demonstrated during the challenge test; C_f = the feed concentration measured during the challenge test; and C_p = the filtrate concentration measured during the challenge test. Equivalent units shall be used for the feed and filtrate concentrations. If the challenge particulate is not detected in the filtrate, the term C_p is set equal to the detection limit for the purpose of calculating the LRV. An LRV shall be calculated for each membrane module evaluated during the challenge test.

6. The removal efficiency of a membrane filtration process demonstrated during challenge testing shall be expressed as a log removal value (LRVC−Test). If fewer than 20 modules are tested, then LRVC−Test is equal to the lowest of the representative LRVs among the modules tested. If 20 or more modules are tested, then LRVC−Test is equal to the 10th percentile of the representative LRVs among the modules tested. The percentile is defined by (i/(n+1)) where i is the rank of n individual data points ordered lowest to highest. If necessary, the 10th percentile may be calculated using linear interpolation.

7. The challenge test shall establish a quality control release value (QCRV) for a non−destructive performance test that demonstrates the *Cryptosporidium* removal capability of the membrane filtration module. This performance test shall be applied to each production membrane module used by the system that was not directly challenge tested in order to verify *Cryptosporidium* removal capability. Production modules that do not meet the established QCRV are not eligible for the treatment credit demonstrated during the challenge test.

8. If a previously tested membrane is modified in a manner that could change the removal efficiency of the membrane or the applicability of the non−destructive performance test and associated QCRV, additional challenge testing to demonstrate the removal efficiency of, and determine a new QCRV for, the modified membrane shall be conducted and submitted to the department.

(d) *Direct integrity testing*. Systems shall conduct direct integrity testing in a manner that demonstrates a removal efficiency equal to or greater than the removal credit awarded to the membrane filtration process and meets the requirements described in subds. 1. to 6. In this subsection, a direct integrity test means a physical test applied to a membrane unit in order to identify and isolate integrity breaches, including one or more leaks that could result in contamination of the filtrate.

1. The direct integrity test shall be independently applied to each membrane unit in service. A membrane unit is defined as a group of membrane modules that share common valving that allows the unit to be isolated from the rest of the system for the purpose of integrity testing or other maintenance.

2. The direct integrity method shall have a resolution of 3 micrometers or less, where resolution is defined as the size of the smallest integrity breach that contributes to a response from the direct integrity test.

3. The direct integrity test shall have a sensitivity sufficient to verify the log treatment credit awarded to the membrane filtration process by the department, where sensitivity is defined as the maximum log removal value that can be reliably verified by a direct integrity test. Sensitivity shall be determined using the approach in either this subd. 3. a. or b. as applicable to the type of direct integrity test the system uses.

a. For direct integrity tests that use an applied pressure or vacuum, the direct integrity test sensitivity shall be calculated according to the following equation:

$LRV_{DIT} = LOG_{10}(Q_p/(VCF \times Q_{breach}))$

Where:

LRV_{DIT} = the sensitivity of the direct integrity test; Q_p = total design filtrate flow from the membrane unit; Q_{breach} = flow of water from an integrity breach associated with the smallest integrity test response that can be reliably measured, and VCF = volumetric concentration factor. The volumetric concentration factor is the ratio of the suspended solids concentration on the high pressure side of the membrane relative to that in the feed water.

b. For direct integrity tests that use a particulate or molecular marker, the direct integrity test sensitivity shall be calculated according to the following equation:

$LRV_{DIT} = LOG_{10}(C_f) - LOG_{10}(C_p)$

Where:

LRV_{DIT} = the sensitivity of the direct integrity test; C_f = the typical feed concentration of the marker used in the test; and C_p = the filtrate concentration of the marker from an integral membrane unit.

4. Systems shall establish a control limit within the sensitivity limits of the direct integrity test that is indicative of an integral membrane unit capable of meeting the removal credit awarded by the department.

5. If the result of a direct integrity test exceeds the control limit established under subd. 4., the system shall remove the membrane unit from service. Systems shall conduct a direct integrity test to verify any repairs, and may return the membrane unit to service only if the direct integrity test is within the established control limit.

6. Systems shall conduct direct integrity testing on each membrane unit at a frequency of not less than 3 times each day that the membrane unit is in operation. The department may approve less frequent testing, based on demonstrated process reliability, the use of multiple barriers effective for *Cryptosporidium*, or reliable process safeguards.

(e) *Indirect integrity monitoring*. Systems shall conduct continuous indirect integrity monitoring on each membrane unit

according to the criteria in subds. 1. to 5. In this subsection, indirect integrity monitoring means monitoring some aspect of filtrate water quality that is indicative of the removal of particulate matter. A system that implements continuous direct integrity testing of membrane units in accordance with the criteria in par. (d) 1. to 5. is not subject to the requirements for continuous indirect integrity monitoring. Water suppliers for systems shall submit a monthly report to the department summarizing all continuous indirect integrity monitoring results triggering direct integrity testing and the corrective action that was taken in each case.

1. Unless the department approves an alternative parameter, continuous indirect integrity monitoring shall include continuous filtrate turbidity monitoring.

2. Continuous monitoring shall be conducted at a frequency of no less than once every 15 minutes.

3. Continuous monitoring shall be separately conducted on each membrane unit.

4. If indirect integrity monitoring includes turbidity and if the filtrate turbidity readings are above 0.15 NTU for a period greater than 15 minutes, or 2 consecutive 15−minute readings above 0.15 NTU, direct integrity testing shall immediately be performed on the associated membrane unit as specified in par. (d) 1. to 5.

5. If indirect integrity monitoring includes a department−approved alternative parameter and if the alternative parameter exceeds a department−approved control limit for a period greater than 15 minutes, direct integrity testing shall immediately be performed on the associated membrane units as specified in par. (d) 1. to 5.

(3) SECOND STAGE FILTRATION. Public water systems receive 0.5−log *Cryptosporidium* treatment credit for a separate second stage of filtration that consists of sand, dual media, GAC, or other fine grain media following granular media filtration if the department approves. To be eligible for this credit, the first stage of filtration shall be preceded by a coagulation step and both filtration stages shall treat the entire plant flow taken from a surface water or GWUDI source. A cap, such as GAC, on a single stage of filtration is not eligible for this credit. The department shall approve the treatment credit based on an assessment of the design characteristics of the filtration process.

(4) SLOW SAND FILTRATION AS SECONDARY FILTER. Public water systems are eligible to receive 2.5−log *Cryptosporidium* treatment credit for a slow sand filtration process that follows a separate stage of filtration if both filtration stages treat entire plant flow taken from a surface water or GWUDI source and no disinfectant residual is present in the influent water to the slow sand filtration process. The department shall approve the treatment credit based on an assessment of the design characteristics of the filtration process. This subsection does not apply to treatment credit awarded to slow sand filtration used as a primary filtration process.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

Subchapter IV — Inactivation Toolbox Components and CT Tables

NR 810.46 Inactivation toolbox components. **(1)** CALCULATION OF CT VALUES. (a) CT is the product of the disinfectant contact time (T, in minutes) and disinfectant concentration (C, in milligrams per liter). Water suppliers for systems with treatment credit for chlorine dioxide or ozone under sub. (2) or (3) shall calculate CT at least once each day, with both C and T measured during peak hourly flow as specified in s. NR 809.563 (1), Table R.

(b) Water suppliers for systems with several disinfection segments in sequence may calculate CT for each segment. In this section, "disinfection segment" means a treatment unit process with a measurable disinfectant residual level and a liquid volume. Under this approach, water suppliers for systems shall add the *Cryptosporidium* CT values in each segment to determine the total CT for the treatment plant.

(2) CT VALUES FOR CHLORINE DIOXIDE AND OZONE. (a) Public water systems receive the *Cryptosporidium* treatment credit for chlorine dioxide by meeting the corresponding chlorine dioxide CT values found in s. NR 810.56 for the applicable water temperature, as described in sub. (1).

(b) Systems receive the *Cryptosporidium* treatment credit for ozone by meeting the corresponding ozone CT values found in s. NR 810.61 for the applicable water temperature.

(3) SITE−SPECIFIC STUDY. The department may approve alternative chlorine dioxide or ozone CT values to those referenced in sub. (2) on a site−specific basis. The department shall base this approval on a site−specific study a water supplier for a system conducts that follows a department−approved protocol.

(4) ULTRAVIOLET LIGHT. Public water systems receive *Cryptosporidium*, *Giardia lamblia*, and virus treatment credits for ultraviolet (UV) light reactors by achieving the corresponding UV dose values shown in s. NR 810.62. Water suppliers for the systems shall validate and monitor UV reactors as described in pars. (b) and (c) to demonstrate that they are achieving a particular UV dose value for treatment credit.

(a) *UV dose table.* The treatment credits listed in the dose table in s. NR 810.62 are for UV light at a wavelength of 254 nm as produced by a low pressure mercury vapor lamp. To receive treatment credit for other lamp types, water suppliers for the systems shall demonstrate an equivalent germicidal dose through reactor validation testing, as described in par. (b). The UV dose values in this table are applicable only to post−filter applications of UV in filtered systems and to unfiltered systems.

(b) *Reactor validation testing.* Systems shall use UV reactors that have undergone validation testing to determine the operating conditions under which the reactor delivers the UV dose required in par. (a), also known as the validated operating conditions. These operating conditions shall include flow rate, UV intensity as measured by a UV sensor, and UV lamp status.

1. When determining validated operating conditions, water suppliers for the systems shall account for the following factors: UV absorbance of the water; lamp fouling and aging; measurement uncertainty of on−line sensors; UV dose distributions arising from the velocity profiles through the reactor; failure of UV lamps or other critical system components; and inlet and outlet piping or channel configurations of the UV reactor.

2. Validation testing shall include the following: Full scale testing of a reactor that conforms uniformly to the UV reactors used by the system and inactivation of a test microorganism whose dose response characteristics have been quantified with a low pressure mercury vapor lamp.

3. The department may approve an alternative approach to validation testing.

(c) *Reactor monitoring.* 1. Water suppliers for the systems shall monitor their UV reactors to determine if the reactors are operating within validated conditions, as determined under par. (b). This monitoring shall include UV intensity as measured by a UV sensor, flow rate, lamp status, and other parameters the department designates based on UV reactor operation. Water suppliers for the systems shall verify the calibration of UV sensors and shall recalibrate sensors in accordance with a protocol the department approves.

2. To receive treatment credit for UV light, systems shall treat at least 99.9% of the water delivered to the public during each month by UV reactors operating within validated conditions for the required UV dose, as described in pars. (a) and (b). Systems shall demonstrate compliance with this condition by the monitoring required under subd. 1.

NR 810.47 CT table for giardia when using free chlorine at 0.5°C or lower.

CT Values for Inactivation of Giardia Cysts by Free Chlorine
0.5°C (32°F) or lower

Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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 = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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	241	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

Note:

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 value at the lower temperature and at the higher pH.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.48 CT table for giardia when using free chlorine at 5°C.

CT Values for Inactivation of Giardia Cysts by Free Chlorine
5°C (41°F)

Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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 = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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	134	183	228	274	55	110	165	219	274	329
1.6	39	77	116	155	193	232	47	94	137	187	234	271	56	112	169	225	281	337
1.8	40	79	119	159	198	238	48	96	141	191	239	287	58	115	173	230	288	345
2	41	81	122	162	203	243	49	98	144	196	245	294	59	118	177	235	294	353
2.2	41	83	124	165	207	248	50	100	147	200	250	300	60	120	181	241	301	361
2.4	42	84	127	169	211	253	51	102	150	204	255	306	61	123	184	245	307	368
2.6	43	86	129	172	215	258	52	104	153	208	260	312	63	125	188	250	313	375
2.8	44	88	132	175	219	263	53	106	156	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

Note:

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 value at the lower temperature and at the higher pH.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.49 CT table for giardia when using free chlorine at 10°C.

CT Values for Inactivation of Giardia Cysts by Free Chlorine
10°C (50°F)

Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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 = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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

Note:

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 value at the lower temperature and at the higher pH.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.50 CT table for giardia when using free chlorine at 15°C.

CT Values for Inactivation of Giardia Cysts by Free Chlorine
15°C (59°F)

Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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 = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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

Note:

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 value at the lower temperature and at the higher pH.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.51 CT table for giardia when using free chlorine at 20°C.

CT Values for Inactivation of Giardia Cysts by Free Chlorine
20°C (68°F)

Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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	21	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	22	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 = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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

Note:

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 value at the lower temperature and at the higher pH.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.52 CT table for giardia when using free chlorine at 25°C.

CT Values for Inactivation of Giardia Cysts by Free Chlorine
25°C (77°F)

Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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	31	6	13	19	25	32	38	8	15	23	31	38	46	9	18	28	37	46	55

Chlorine Concentration (mg/L)	pH = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤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

Note:

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 value at the lower temperature and at the higher pH.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.53 CT table for viruses when using free chlorine.

CT Values for Inactivation of Viruses by Free Chlorine

Temperature, °C	Log Inactivation							
	1.0 pH		2.0 pH		3.0 pH		4.0 pH	
	6 – 9	10	6 – 9	10	6 – 9	10	6 – 9	10
0.5	3	23	6	45	9	66	12	90
5	2	15	4	30	6	44	8	60
10	2	11	3	22	4	33	6	45
15	1	8	2	15	3	22	4	30
20	1	6	1	11	2	16	3	22
25	1	3	1	7	1	11	2	15

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.54 CT table for *Giardia lamblia* when using chlorine dioxide.

CT Values for Inactivation of *Giardia lamblia* Cysts by Chlorine Dioxide

Inactivation	Temperature, °C					
	≤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

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.55 CT table for viruses when using chlorine dioxide.

CT Values for Inactivation of Viruses by Chlorine Dioxide pH 6–9

Inactivation	Temperature, °C					
	≤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

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.56 CT table for *Cryptosporidium* when using chlorine dioxide. [1]

Log credit	Water Temperature, °C										
	≤0.5	1	2	3	5	7	10	15	20	25	30
0.25	159	153	140	128	107	90	69	45	29	19	12
0.5	319	305	279	256	214	180	138	89	58	38	24
1.0	637	610	558	511	429	360	277	179	116	75	49
1.5	956	915	838	767	643	539	415	268	174	113	73
2.0	1275	1220	1117	1023	858	719	553	357	232	150	98
2.5	1594	1525	1396	1278	1072	899	691	447	289	188	122
3.0	1912	1830	1675	1534	1286	1079	830	536	347	226	147

[1]Systems may use this equation to determine log credit between the indicated values: Log credit = (0.001506 × (1.09116)Temp) × CT.

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.57 CT table for *Giardia lamblia* when using chloramines.

CT Values for Inactivation of *Giardia lamblia* Cysts by Chloramine pH 6–9

Inactivation	Temperature, °C					
	≤1	5	10	15	20	25
0.5–log	635	365	310	250	185	125
1–log	1,270	736	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

History: CR 09–073: cr. Register November 2010 No. 659, eff. 12–1–10.

NR 810.58 CT table for viruses when using chloramines.

CT Values for Inactivation of Viruses by Chloramine

Inactivation	Temperature, °C					
	≤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

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.59 CT table for *Giardia lamblia* when using ozone.

CT Values for Inactivation of *Giardia lamblia* Cysts by Ozone

Inactivation	Temperature, °C					
	≤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

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.60 CT table for viruses when using ozone.

CT Values for Inactivation of Viruses by Ozone

Inactivation	Temperature, °C					
	≤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

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.61 CT table for *Cryptosporidium* when using ozone. [1]

Log credit	Water Temperature, °C										
	≤0.5	1	2	3	5	7	10	15	20	25	30
0.25	6.0	5.8	5.2	4.8	4.0	3.3	2.5	1.6	1.0	0.6	0.39
0.5	12	12	10	9.5	7.9	6.5	4.9	3.1	2.0	1.2	0.78
1.0	24	23	21	19	16	13	9.9	6.2	3.9	2.5	1.6
1.5	36	35	31	29	24	20	15	9.3	5.9	3.7	2.4
2.0	48	46	42	38	32	26	20	12	7.8	4.9	3.1
2.5	60	58	52	48	40	33	25	16	9.8	6.2	3.9
3.0	72	69	63	57	47	39	30	19	12	7.4	4.7

[1]Systems may use this equation to determine log credit between the indicated values: Log credit = (0.0397 × (1.09757)Temp) × CT.

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.

NR 810.62 UV dose table for *Cryptosporidium, Giardia lamblia,* and viruses.

Log credit	Cryptosporidium UV dose (mJ/cm^2)	Giardia lamblia UV dose (mJ/cm^2)	Virus UV dose (mJ/cm^2)
0.5	1.6	1.5	39
1.0	2.5	2.1	58
1.5	3.9	3.0	79
2.0	5.8	5.2	100
2.5	8.5	7.7	121
3.0	12	11	143
3.5	15	15	163
4.0	22	22	186

History: CR 09−073: cr. Register November 2010 No. 659, eff. 12−1−10.