

**Appleton SWTR Disinfection Requirements and Compliance Summary**

**System Name:** Appleton Water Utility  
**PWSID No:** 44503338  
**Plant Capacity:** Design – 24 MGD

**Note:** Plant capacity limited to 16 MGD at water temp <6° C and if the UV system is out of service.

**Approved Baseline:** 24 MGD  
**Plant Type:** Lime softening, GAC filtration, UV  
**LT2 ESWTR Bin Placement:** 1  
**Issue Date:** June 18, 2012  
 Revised July 5, 2012, June 26, 2017

<b>Removal/Inactivation Credits</b>			
<b>Process</b>	<b>Giardia</b>	<b>Viruses</b>	<b>Cryptosporidium</b>
Lime softening (coagulation) & filtration	2.5 logs <sub>1</sub>	2.0 logs <sub>1</sub>	3.0 logs <sub>1</sub>
UV Disinfection	3.0 logs <sub>2</sub>	0 logs	3.0 logs <sub>3</sub>
Free chlorine CT	0.5 logs <sub>4</sub>	4.0 logs <sub>5</sub>	0 logs
<b>Total provided with normal operation<sub>6,7</sub></b>	<b>6.0 logs</b>	<b>6.0 logs</b>	<b>6.0 logs</b>
Required per Bin 1	3.0 logs	4.0 logs	3.0 logs

- 1 Credit based on meeting IESWTR turbidity requirements.
- 2 Will be met if dose for 3.0-log Cryptosporidium inactivation is met
- 3 Credit based on providing minimum specified RED and operating within validated specifications
- 4 Credit based on meeting required 0.5-log Giardia CT values using free chlorine in CT basin. Utility is currently using this as free chlorine CT goal.
- 5 Credit based on meeting required 4-log virus CT values using free chlorine in CT basin. 4-log virus inactivation will be provided if 0.5 log giardia inactivation CT is met.
- 6 Normal operation includes operating UV for 3 log crypto inactivation and providing 0.5 log Giardia inactivation with free chlorine CT
- 7 The LT2 toolbox allows a system to claim an additional 0.5 log cryptosporidium removal credit if CFE is less than 0.15 NTU and an additional 0.5 log cryptosporidium removal credit if individual filter turbidity is less than 0.3 NTU. Additional monitoring requirements would apply.

**Lime Softening & Filtration - Turbidity Requirements**

Based on the Interim Enhanced Surface Water Treatment Rule (IESWTR), the Department is granting 2.5 logs giardia, 2.0 logs virus and 3.0 logs cryptosporidium removal credit for the lime softening/filtration process provided that:

- The turbidity of filtered water samples, taken every 4 hours, be less than or equal to 0.3 NTU in at least 95% of the samples taken each month. The maximum value for each day of the 4 hour samples are reported on the monthly operating report.
- No turbidity result may be greater than 1 NTU.

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Sample lines run from both the north and south combined filter effluent (CFE) lines to the lab. The Utility takes a grab sample from both every 4 hours for a total of 12 turbidity results per day.

### UV Disinfection

The UV system is intended to provide a minimum 3.0-log inactivation of cryptosporidium (and giardia) inactivation. To ensure continuous compliance, it is proposed to operate the UV system to meet an MS2 validated dose of 12 mJ/cm<sup>2</sup>. A validation factor of 3.29 results in a reduction equivalent dose (RED) of 39.4 mJ/cm<sup>2</sup>. An off-spec (minimum) dose of 32 mJ/cm<sup>2</sup> will be used. Based on the validation testing, actual RED required doses are somewhat less and depend on the UVT. The UV system PLC will adjust the reactor lamp power to provide the target dose while incorporating the variable operating conditions of flow, UVT and lamp output. By using a target dose of 40 mJ/cm<sup>2</sup>, the required dose will be met during changing conditions. A reactor is considered to be off-spec if any of the following occur while there is flow through the reactor:

- The measured UVT is less than or equal to 70 per cent.
- The measured flow is greater than 26 MGD per reactor. This is the maximum flow each reactor is validated for. Each side of the plant is not likely to operate beyond the rated hydraulic capacity of 12 MGD.
- The failure of 1 or more lamps, or 1 or more ballasts.
- The calculated RED is less than 32 mJ/cm<sup>2</sup> for UVT values greater than or equal to 72 per cent or 34 mJ/cm<sup>2</sup> for UVT values of 71 per cent.

To receive 3-log disinfection credit for the UV disinfection, 99.9 per cent of the water (by volume) sent to the distribution system must be treated within the validated range for the reactors. Therefore, if the total amount of off-spec water sent to the system exceeds 0.1 per cent of the total treated for a given month, a treatment technique violation may have occurred and the appropriate follow-up public notifications may be required. However, if Appleton remains a Bin 1 system, sufficient removal and inactivation credits are available with the lime softening/filtration and chlorine disinfection processes to meet the current regulations. UV is provided for additional enhanced disinfection, but is not required.

Note: Plant capacity might be limited to less than 24 MGD during periods of cold water temperature if the UV system is out of service. Limitations could be the result of CT basins not being able to provide a minimum 0.5-log giardia inactivation. Capacity limitations, if any, will depend on actual water temperature, pH and chlorine residual at the time the UV system is out of service.

### Chlorine Residual

#### Requirements

- Minimum 0.2 mg/L disinfectant residual entering the distribution system as per NR 810.31(1)(b), Wis. Adm. Code (from SWTR)
- Minimum 1.0 mg/L combined chlorine residual entering the distribution system as per NR 811.42(5), Wis. Adm. Code
- Detectable residual throughout the distribution system
- Continuous disinfectant residual monitoring at the entry point

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### Chlorine Feed

- Fed to UV discharge at about 3 mg/L.

### Chlorine Residual Monitoring

- ATI Q46H/62 continuous free chlorine analyzers just prior to the CT tank providing feedback to the chlorine feed equipment to maintain constant dose
- Hach CL17 continuous free chlorine residual analyzers from the effluent weirs from both CT basins via pumped sample lines.
- Grab samples for free chlorine taken every two hours from the effluent weirs from both CT basins via pumped sample lines to the lab. The minimum level for each day is reported on the monthly operating report.
- Hach CL17 continuous total chlorine analyzers on the north and south high service pump discharge header lines (entry points).
- Grab samples for total chlorine taken every two hours from the north and south high service pump discharge header lines (entry points). The minimum level for each day is reported on the monthly operating report.

### Disinfection by Free Chlorine CT

In order to provide sufficient inactivation of cysts and viruses, the level of disinfection must meet a prescribed CT value. CT is defined as the disinfectant residual in mg/l multiplied by the contact time in minutes.

The Utility is currently using a free chlorine target of 0.5-log giardia which is the level required if the UV is not operating. This level will also provide greater than 4.0 logs of virus inactivation by free chlorine CT. The required CT's are pH, temperature and sometimes chlorine level dependent. Required CT values for giardia can be found in s. NR 810.47 through 810.52 and viruses can be found in s. NR 810.53, Wis. Adm. Code from which the following table is derived. For temperatures between those listed in the code, either the conservative value or interpolation is used. Virus CT values for pH between 9 and 10 are determined by straight line interpolation and increase quickly for pH values above 9. Typical pH in the CT tanks is 8.6 and it is planned to operate below pH 9.0 at all times.

Temperature	Required CT (mg/L-min)			
	Virus Inactivation		Giardia Inactivation	
	4-log pH 6 to 9	2-log pH 6 to 9	0.5-log, pH 8.6	
			Cl =2.0	Cl=2.5
0.5° C	12	6	70.5	74.5
5° C	8	4	51.5	54.5
10° C	6	3	36.4	38.5
15° C	4	2	25.7	27.2
20° C	3	1.5	18.2	19.2
25° C	2	1	12.8	13.5

Chlorine is fed into the UV discharge lines prior to the CT basins and typically enters the CT tanks at a free residual of 3.0 mg/L. Aqua ammonia is fed at the outlet weir from the CT basins to the clearwells to convert the free chlorine to chloramines.

The CT basins provide free chlorine contact time. The two original parallel CT basins have a fixed volume of 166,000 gallons for a total volume of 332,000 gallons. Both basins were extended in 2014 with an additional 134,200 gallons each yielding parallel CT basins with

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300,200 gallons each. A weir at the end of each basin maintains a minimum water level throughout the basins. Baffles were also added in the original and new basins. Tracer testing was conducted in the basins in October 2015 at flow rates of 4 and 11 MGD per basin. The fluoride was added at the normal feed location 75 feet upstream of the CT basins. Chlorine is fed at the same location. Samples were taken near the outlet weirs of the CT basins. The tests showed baffle factors ranging from 0.5 to 0.67 for basins 1A and 2A and baffle factors ranging from 0.64 to 0.7 for basins 1A/1B and 2A/2B.

The Department approved the use of the following baffle factors:

- 0.6 for Basins 1A/1B and 2A/2B – To be used when ammonia is fed at the end of basins 1B and 2B. This option provides the greatest free chlorine contact time and unless disinfection byproducts are a problem, is expected to be the normal mode of operation.
- 0.5 for Basins 1A and 2A – To be used when ammonia is fed at the end of basins 1A and 2A.

The following  $T_{10}$  times can be assumed with both extended CT basins in service and using a 0.6 baffle factor:

Plant Flow Rate (MGD)	CT Basin Flow Rate (MGD)	Contact time $T_{10}$ (min)
8	4	64.9
10	5	51.9
12	6	43.2
14	7	37.1
16	8	32.4
18	9	28.8
20	10	26.0
22	11	23.6
24	12	21.6

The meters on the UV reactor lines will be used to calculate  $T_{10}$ . The free chlorine residual and pH are monitored by grab sample (in the lab) every 2 hours from both effluent weirs of the CT basins.

$$\text{Inactivation Ratio} = \text{CT (calculated)} / \text{CT (required)}$$

The inactivation ratio is used to compare the calculated CT value to the CT values required by the tables. Compliance is achieved if the inactivation ratio is greater than 1.0.

CT is calculated every 2 hours resulting in 24 data sets each day when both CT trains are in service or 12 data sets when one CT train is in service. The data set resulting in the lowest CT ratio is reported on the monthly operating report. The reported data set includes the associated flow (gpm),  $T_{10}$  (minutes), CT Calculated (mg/L-minutes), CT Required (mg/L-minutes), and Inactivation Ratio. Also reported from all the data sets each day are the minimum free chlorine residual (mg/L), average pH (SU), and water temperature ( $^{\circ}\text{C}$ )

The Department is granting a 0.5 log giardia inactivation credit provided that:

- The inactivation ratio based on 0.5 log giardia values is greater than 1.0 at all times.

The Department is granting a 2 or 4 log virus inactivation credit provided that:

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- The inactivation ratio based on a 2 or 4-log virus CT values is greater than 1.0 at all times, or
- The inactivation ratio for giardia is greater than 1.0

As seen in the table above, the CT values required for 0.5-log giardia inactivation are higher than those shown for viruses.

No cryptosporidium inactivation credit is available for free chlorine.

### Reporting

The following list of parameters will need to be reported on the monthly operating report (MOR) to show compliance specific to the Surface Water Treatment Rules:

- The maximum combined filter effluent turbidity level for each day.
- The minimum total chlorine residual level entering the distribution system (daily).
- The minimum inactivation ratio for the CT basins based on a 0.5 log Giardia inactivation (daily).
- Monthly UV dose setpoint (40 mJ/cm<sup>2</sup>) and regulatory dose (32 mJ/cm<sup>2</sup>)
- Treated flow
- Actual dose ratio (minimum delivered dose / regulatory dose)
- UVT (online and lab)
- Number of off-spec events per day
- Volume of off-spec water per day
- Per cent off-spec water per day and month
- Sensor check vs. reference (monthly)

As is already being done, other operational parameters are also required to be reported on the monthly operating report.

### Potential for Change

The above listed credits and requirements are based on the plant processes and requirements that are in place today. Any of the following have the potential to change the assumptions used for this determination:

- The surface water treatment rules could be changed by US EPA.
- The Utility could make modifications to the treatment plant. Any significant changes in disinfection practices must be approved by the Department and may require disinfection profiling and benchmarking (NR 810.32).
- The second round of cryptosporidium monitoring, as required by the LT2ESTR began October 1, 2015, could place the Utility in a different bin.

It is intended that this document will be updated as changes are made.