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SIGNATURES:

April Grippo
Director, Division of Water Resources

Grant Ruhl
Reviewer

Tim Hill, PE
Drafter / Preparer

Revision History Table

Revision	Date	Brief Summary of Change
0	1/2016	Original Document
1	7/2025	Overall update to Chapter 10

CHAPTER 10
Disinfection

APPENDICES

DISINFECTION

10.1 General

10.1.1 Standards of Performance

This chapter of the Design Criteria for the Review of Sewage Works Construction Plans and Documents ("*Criteria*") provides guidance for meeting the following performance standards for wastewater disinfection. Note that there may be additional requirements for chemical handling, storage and protection based on other Federal, State and Local regulations that are not covered in this *Criteria*.

The construction documents, including final plans, specifications, engineering reports and calculations should be prepared in accordance with Chapter 1 of the *Criteria*. The documents should incorporate the technical standards in this chapter and be sufficient for construction of a system capable of an appropriate level of pathogen reduction in the wastewater across the entire range of flow conditions at the treatment plant.

In addition to the efficacy of treatment to meet permit conditions, the design should consider operability, maintainability, reliability, and life cycle cost of the proposed system.

10.1.2 Requirement for Disinfection

Disinfection minimizes the potential transmission of infectious diseases by destroying or inactivating pathogenic agents in the effluent. Proper disinfection of treated wastewater before disposal is required (with the exception of some land application systems) to protect public health and the environment.

10.1.3 Methods of Disinfection

10.1.3.1 Chlorination

The chemical compounds most commonly used are chlorine (Cl_2), bulk or on-site generated (OSG) sodium hypochlorite ($NaOCl$) and calcium hypochlorite [$Ca(OCl)_2$]. Chlorination should be used unless other factors, including chlorine availability, costs, or environmental concerns, justify an alternative method.

10.1.3.2 Ozonation

Ozonation may be considered as an alternative to chlorination for the reasons described above. Ozonation should only be considered for medium to large installations, where environmental concerns or other factors would justify its use.

10.1.3.3 Ultraviolet Light

Ultraviolet (UV) light is the most common form of electromagnetic radiation used to disinfect wastewater. The germicidal properties of UV fall in the wavelength range of 220 to 265 nm. UV systems may vary based on lamp type, channel design, and other manufacturer specific technologies.

10.1.3.4 Peracetic Acid

Peracetic Acid (PAA) is a chemical compound resulting from a reaction between acetic acid and hydrogen peroxide. PAA has a high oxidation potential. Due to site specific water quality concerns, a PAA design may need to include pilot scale testing prior to implementation.

10.1.3.5 Other

Other potential methods of disinfection are available and their application will be considered on a case-by-case basis.

10.1.4 Dechlorination

Capability to add dechlorination should be considered in all new treatment plants with surface water discharges that utilize chlorine disinfection. Dechlorination of chlorinated effluents should be provided when permit conditions dictate the need. Though not specifically described in this *Criteria*, quenching of other chemical compounds, such as PAA, should also be considered based on site specific conditions.

10.2 Chlorination

10.2.1 Application

10.2.1.1 Forms of Chlorine

a. Dry Chlorine

Dry chlorine is defined as elemental chlorine existing in the liquid or gaseous phase, containing less than 150 mg/l water. Unless otherwise stated, the word "chlorine" wherever used in this section refers to dry chlorine.

b. Sodium Hypochlorite

Sodium hypochlorite may be used as an alternative to chlorine whenever dry chlorine availability, cost, or public safety justifies its use. Concentrations usually range between 12.5 to 17 percent available chlorine for bulk sodium hypochlorite and 0.8% for on-site generation. On-site generation criteria are not specifically outlined, but may be reviewed on a case-by-case basis.

c. Calcium Hypochlorite

Commonly available in tablet or granular form, calcium hypochlorite is typically reserved for small installations due to handling constraints. Note that only calcium hypochlorite tablets should be used. Commonly available chlorine tablets for swimming pools use a different form of chlorine and are not acceptable for wastewater applications.

d. Other

Other chlorine compounds such as chlorine dioxide or bromine chloride may be used as alternatives to chlorine whenever cost or environmental concerns justify their use. The acceptability of other chlorine compounds will be determined on a case-by-case basis.

10.2.2 Design Basis

10.2.2.1 General

The effectiveness of a chlorine disinfection system is based on contact time, mixing, chemical characteristics of the wastewater, pH, temperature and concentration of organisms.

Advantages include a well documented history of use as an effective disinfectant, ease of monitoring, presence of a germicidal residual in long transmission lines and general lower overall cost.

Disadvantages include worker and public safety, long contact times, potential requirements for dechlorination, formation of DBPs, acid generation and costs associated with hazardous chemical planning and reporting on both the state and local levels (PSM Plans and RMPs).

10.2.2.2 Dosage

Required chlorinator capacities will vary, depending on the use and point of application of the chlorine. Chlorine dosage should be established for each individual situation, with those variables affecting the chlorine reaction taken into consideration. For domestic wastewater, the following dosing capacity may be used as a guideline.

Type of Treatment	Dosage Capacity* (mg/L)
Stabilization Pond effluent	Up to 35
Trickling Filter effluent	10-15
Activated Sludge (non-nitrified) effluent	2-8
Nitrified effluent	2-6
Tertiary Filtered effluent	2-6

*Based on average daily flow

The design should provide adequate flexibility in the chlorination equipment and control system to allow controlled chlorination at minimum and peak flows over the entire life of the treatment plant. Special consideration should be given to the chlorination requirements during the first years of operation to ensure the chlorination system is readily operable at less than design flows without overchlorination. Chlorination equipment should operate between 25% and 75% of total operating range, to allow for adjusting flexibility at design average flow.

For treatment facility designs greater than 0.5 mgd, continuously modulated dosage control systems should be used. The control system should adjust the chlorine dosage rate to accommodate fluctuations in effluent chlorine demand and residual caused by changes in waste flow and waste characteristics. These facilities should also utilize continuous chlorine residual monitoring.

Flow proportional control is preferred over manual control for smaller facilities as well and may be required on a case-by-case basis. The design should shut off the chlorination for small systems where the flow is zero, such as late at night.

10.2.2.3 Mixing

The mixing of chlorine and wastewater can be accomplished by hydraulic or mechanical mixing. Hydraulic mixing is preferred in smaller plants over mechanical mixing and should be done according to the following criteria.

a. Pipe Flow:

A Reynolds Number of greater than or equal to 1.9×10^4 is required. Pipes up to 30 inches in diameter: chlorine injected into center of pipe. Pipes greater than 30 inches in diameter: chlorine injected with a grid-type diffuser. Chlorine applied at least 10 pipe diameters upstream from inlet to contact tank.

b. Open channel flow:

A hydraulic jump with a minimum Froude Number of 4.5 is necessary to provide adequate hydraulic mixing. Point of chlorine injection must be variable because jump location will change with changes in flow.

c. Mechanical Mixing:

When mechanical mixing must be used, the following criteria apply:

Use where Reynolds Number for pipe flow is less than 1.9×10^4 or for open channel flow without a hydraulic jump. A mixer-reactor unit is necessary that provides 6 to 18 seconds contact. Inject chlorine just upstream from mixer. Mixer speed a minimum of 50 revolutions per minute (rpm).

Jet Chlorinators may be used in a separate chamber from the contact chamber. The contact chamber should conform to section 10.2.2.5 with an average design flow minimum detention time reduced to 15 minutes and a peak detention time of 7.5 minutes.

10.2.2.4 Contact Period

Contact chambers should be sized to provide a minimum of 30 minutes detention at average design flow and 15 minutes detention at daily peak design flow, whichever is greater. Contact chambers should be designed so detention times are less than two hours for initial flows.

10.2.2.5 Contact Chambers

The contact chambers should be baffled to minimize short-circuiting and backmixing of the chlorinated wastewater to such an extent that plug flow is approached. It is recommended that baffles be constructed parallel to the longitudinal axis of the chamber with a minimum length-to-width ratio of 30:1 (the total length of the channel created by the baffles should be 30 times the distance between the baffles). Shallow unidirectional contact chambers should also have cross-baffles to reduce short-circuiting caused by wind currents.

Provision should be made for removal of floating and settleable solids from chlorine contact tanks or basins without discharging inadequately disinfected effluent. To accomplish continuous disinfection, the chlorine contact tank should be designed with duplicate compartments to permit draining and cleaning of individual compartments. A sump or drain within each compartment, with the drainage flowing to a raw sewage inlet, should be provided for dewatering, sludge accumulation, and maintenance. Unit drains shall not discharge into the outfall pipeline.

In lagoon systems or other systems with poor upstream solids removal, baffles should be considered to prevent the discharge of floating material.

A readily accessible sampling point should be provided at the outlet end of the contact chamber.

In some instances, the effluent line may be used as chlorine contact chambers provided that the conditions set forth above are met.

10.2.3 Equipment

10.2.3.1 Housing

a. General

An enclosed structure should be provided for the chlorination equipment.

Chlorine cylinder or container storage area should be shaded from direct sunlight.

Chlorination systems should be protected from fire hazards, and water should be available for cooling cylinders or containers in case of fire.

Any building which will house chlorine equipment or containers should be designed and constructed to protect all elements of the chlorine system from fire hazards. If flammable materials are stored or processed in the same building with chlorination equipment (other than that utilizing hypochlorite solutions), a firewall should be erected to separate the two areas.

If dry chlorination equipment and chlorine cylinders or containers are to be in a building used for other purposes, a gastight partition shall separate this room from any other portion of the building. Doors to this room shall open only to the outside of the building and shall be equipped with panic hardware. Such rooms should be at or above ground level and should permit easy access to all equipment.

A reinforced glass, gastight window shall be installed in an exterior door or interior wall of the chlorinator room to permit the chlorinator to be viewed without entering the room.

Adequate room must be provided for easy access to all equipment for maintenance and repair. The minimum acceptable clearance around and in back of equipment is 2 feet, except for units designed for wall or cylinder mounting.

b. Heat

Chlorinator rooms should have a means of heating and controlling the room air temperature above a minimum of 55° F. A temperature of 65° F is recommended.

The room housing chlorine cylinders or containers in use should be maintained at a temperature less than the chlorinator room, but in no case less than 55° F unless evaporators are used and liquid chlorine is withdrawn.

All rooms containing chlorine should also be protected from excess heat.

c. Ventilation

All chlorine feed rooms and rooms where chlorine is stored should be force-ventilated, with one air change per minute when the room is occupied, with the fan interlocked with the door or light switch. Continuous ventilation needs to be reviewed by a HVAC engineer.

Chlorinators and some accessories require individual vents to a safe outside area. The vent should terminate not more than 25 feet above the chlorinator or accessory and have a slight downward slope from the highest point. The outside end of the vent should bend down to preclude water entering the vent and be covered with a screen to exclude insects.

d. Electrical

Electrical controls for lights and the ventilation system should operate automatically when the entrance doors are opened. Manually controlled override switches should be located adjacent to and outside of all entrance doors, with an indicator light at each entrance. Electrical controls should be excluded, insofar as possible, from rooms containing chlorine cylinders, chlorine piping, or chlorination equipment.

e. Incompatible Equipment

Dechlorination equipment (SO_2) should not be placed in the same room as gaseous Cl_2 equipment. SO_2 equipment is to be located such that the safety requirements of handling Cl_2 are not violated in any form or manner.

10.2.3.2 Piping and Connections

a. Dry Chlorine

Piping systems should be as simple as possible, with a minimum number of joints; piping should be well supported, adequately sloped to allow drainage, protected from mechanical damage, and protected against temperature extremes.

The piping system to handle gas under pressure should be constructed of Schedule 80 black seamless steel pipe with 2,000-pound forged steel fittings. Unions should be ammonia type with lead gaskets. All valves should be Chlorine Institute-approved. Gauges should be equipped with a silver protector diaphragm.

Piping can be assembled by either welded or threaded connections. All threaded pipe must be cleaned with solvent, preferably trichlorethylene, and dried with nitrogen gas or dry air. Teflon tape should be used for thread lubricant in lieu of pipe dope.

b. Injector Vacuum Line

The injector vacuum line between the chlorinator and the injector should be Schedule 80 PVC or fiber cast pipe approved for moist chlorine use.

c. Chlorine Solution

The chlorine solution lines can be Schedule 40 or 80 PVC, rubber-lined steel, cPVC, or fiberglass-reinforced plastic (FRP), approved for moist chlorine use. Valves should be PVC, PVC-lined, or rubber- lined.

10.2.3.3 Chlorine Feed Equipment

Solution-feed vacuum-type chlorinators are generally preferred for large installations. The use of hypochlorite feeders of the positive displacement type may be considered.

Liquid chlorine evaporators should be considered where more than four one-ton containers will be connected to a supply manifold.

Flow through tablet chlorinators should allow for stacking across the range of flowrates, ease of access for refilling and hydraulic conditions to ensure appropriate dosage of the effluent.

10.2.3.4 Chlorine Gas Withdrawal Rates

The maximum withdrawal rate for 100- and 150- pound cylinders should be limited to 40 pounds per day per cylinder.

When gas is withdrawn from 2,000-pound containers, the withdrawal rate should be limited to 400 pounds per day per container.

10.2.3.5 Water Supply

An ample supply of water should be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided, and, when necessary, standby power as well. When connection is made from domestic water supplies, equipment for backflow prevention shall be provided. Where treated effluent is used, a wye strainer should be added. Pressure gauges should be provided on chlorinator water supply lines.

10.2.3.6 Standby Equipment and Spare Parts

Standby chlorination capabilities should be provided which will ensure adequate disinfection with any unit out of operation for maintenance or repairs. An adequate inventory of parts subject to wear and breakage should be maintained at all times.

10.2.3.7 Scales

Scales shall be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. Scales shall be provided for each cylinder or container in service; one scale is adequate for a group of cylinders or containers connected to a common manifold. Scales should be constructed of or coated with corrosion-resistant material. Scales should be recommended for day tanks when using High Test Hypochlorite (HTH)

10.2.3.8 Handling Equipment

Handling equipment should be provided as follows for 100- and 150-pound cylinders:

- A hand truck specifically designed for cylinders
- A method of securing cylinders to prevent them from falling over

Handling equipment should be provided as follows for 2,000-pound containers:

- Two-ton-capacity hoist
- Cylinder lifting bar
- Monorail or hoist with sufficient lifting height to pass one cylinder over another
- Cylinder trunnions to allow rotating the cylinder for proper connection

10.2.3.9 Automatic Switchover of Cylinders and Containers

Automatic switchover of chlorine cylinders and containers at facilities having less than continuous operator attendance is desirable and will be required on a case-by-case basis.

10.2.4 Chlorine Supply

a. Cylinders

Cylinders should be considered where the average daily chlorine use is 150 pounds or less. Cylinders are available in 100-pound or 150-pound sizes.

b. Containers

The use of 1-ton containers should be considered where the average daily chlorine consumption is over 150 pounds.

c. Large-Volume Shipments

At large installations, consideration should be given to the use of truck or railroad tank cars, or possibly barge tank loads, generally accompanied by gas evaporators.

d. Liquid Tanks

Storage containers for hypochlorite solutions should be of sturdy, non-metallic lined construction and provided with secure tank tops and pressure relief and overflow piping. The overflow piping should be provided with a water seal or other device to prevent the tank from venting to the indoors. Provision should be made for adequate protection from light and extreme temperatures. Tanks should be located where leakage will not cause corrosion or damage to other equipment.

e. Tablet Systems

Tablets should be stored in closed containers in a cool, dry, well-ventilated area.

10.2.5 Storage

10.2.5.1 Container Space

Sufficient space should be provided in the supply area for at least one spare cylinder or container for each one in service.

10.2.5.2 Tanks

Due to the deterioration of the hypochlorite solutions over time, it is recommended that containers not be sized to hold more than one month's needs. Ultimately, requirements for storage volume should be evaluated based on average and peak demand and consideration toward the availability of resupply shipments.

A means of secondary containment should be provided to contain spills and facilitate clean up. The volume of secondary containment should be 110% the volume of the tank.

10.2.6 Safety

10.2.6.1 Leak Detection and Controls

When dry chlorine is used, a bottle of 56% ammonium hydroxide solution shall be available for detecting chlorine leaks.

All installations utilizing 2,000-pound containers and having less than continuous operator attendance shall have suitable continuous chlorine leak detectors. Continuous chlorine leak detectors would be desirable at all installations. Whenever chlorine leak detectors are installed, they should be connected to a centrally located alarm system and shall automatically start exhaust fans.

10.2.6.2 Breathing Apparatus

At least one gas mask in good operating condition and of a type approved by the National Institute for Occupational Safety and Health (NIOSH) as suitable for high concentrations of chlorine gas shall be available at all installations where chlorine gas is handled and shall be stored outside of any room where chlorine is used or stored. Instructions for using, testing, and replacing mask parts, including canisters, shall be posted. At large installations, where 1-ton containers are used, self- contained air breathing apparatus of the positive pressure type shall be provided.

10.2.6.3 Container Repair Kits

All installations utilizing 1-ton containers should have Chlorine Institute Emergency Container Kits. Other installations using cylinders should have access to kits stored at a central location.

10.2.6.4 Eye Wash Station

Suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.

10.2.6.5 Piping Color Codes

It is desirable to color code all piping related to chlorine systems (see ANSI/ASME A13.1).

10.2.6.6 Alarms

Alarms and monitoring equipment that adequately alert the operators in the event of deficiencies, malfunctions, or hazardous situations related to chlorine supply metering equipment, leaks, and residuals may be required on a case-by-case basis.

10.2.7 Dechlorination

10.2.7.1 Application

10.2.7.2 Types

a. Sulfur Dioxide

Sulfur dioxide can be purchased, handled, and applied to wastewater in the same way as chlorine. Sulfur dioxide gas forms sulfurous acid, a strong reducing agent, when combined with water. When mixed with free and combined chlorine residuals, sulfurous acid will neutralize these active chlorine compounds to the nontoxic chloride ion.

Sulfur dioxide dosage required for dechlorination is approximately 1 mg/l of SO_2 for 1 mg/l of chlorine residual expressed as Cl_2. Reaction time is essentially instantaneous. Detention time requirements are based on the time necessary to assure complete mixing of the sulfur dioxide.

b. Sulfite/bisulfite

Typically supplied as an aqueous solution of 38% concentration but may come in varying strengths.

c. Tablet

Dechlorination can be achieved through the use of a tablet system, though is typically reserved for small installations.

d. Other Methods

For very small treatment systems, detention ponds could be considered for dechlorination.

10.2.7.3 Design Basis

10.2.7.3.1 General

Dechlorination may be necessary to reduce the toxicity of the chlorine residual of the disinfected effluent. The method and dosage will depend on the chlorine demand and the requirements of the receiving stream.

10.2.7.3.2 Dosage

Required capacity will vary, depending on the residual chlorine in the effluent and type of chemical used. Dosage should be established for each individual situation. The following forms of the compound are commonly used with their associated dosing ratios. Typically an excess of 10% chemical is required above these values to account for mixing conditions. Note that excess sulfur dioxide may consume oxygen at a maximum of 1 mg/l of dissolved oxygen for every 4 mg/l of SO2.

Dechlorination Chemical	Theoretical mg/l required to Neutralize 1 mg/l Cl2
Sodium thiosulfate (solution)	0.56
Sodium sulfite (tablet)	1.78
Sulfur dioxide (gas)	0.9
Sodium meta bisulfite (solution)	1.34
Sodium bisulfite (solution)	1.46

10.2.7.4 Mixing and Contact Period

The dechlorination reaction with free or combined chlorine will generally occur within 15-20 seconds. The design should allow for a minimum of 30 seconds contact time. The chemical should be introduced at a point in the process where hydraulic turbulence is adequate to assure thorough and complete mixing. If no such point exists, mechanical mixing should be provided. Consideration should be given to reaeration following the chemical application to maintain an adequate dissolved oxygen concentration in the effluent.

10.2.7.5 Equipment, Supply, Storage and Safety

10.2.7.5.1 Chemical Feed Equipment, Piping and Safety

In general, the same type of feed equipment used for chlorine may be used with minor modifications. The manufacturer should be contacted for specific equipment recommendations. No equipment should be alternatively used for the two products. Common pumps for sulfur dioxide gas include a vacuum solution feed and positive displacement pumps used for aqueous solutions. Ensure the pumps can operate over the entire range of flows and required dosing rates.

Standby equipment, water supply and housing requirements are generally the same as those in section 10.2.3

10.2.7.5.2 Dechlorination Supply

The type of container will depend on the chemical selected and capacity requirements. Gas cylinders are typically available from 100 lbs to 1-ton. Drums, Totes and IBCs from 50 to 550 gallons are available for liquid solutions. Larger storage tanks of various sizes are also available and should follow the guidance provided in section 10.2.4. Dilution tanks and mixing tanks are required when using dry compounds.

10.2.7.5.3 Storage

Storage considerations and requirements should follow the guidance listed in section 10.2.5.

10.2.7.5.4 Safety

Safety considerations and requirements should follow the guidance provided in section 10.2.6.

10.3 Ozonation

10.3.1 Application

Ozonation may be substituted for chlorination whenever chlorine availability, cost, or environmental benefits justify its application.

Ozone is generated on-site from either air or high-purity oxygen. Ozonation should be considered if high-purity oxygen is available at the plant for other processes.

10.3.2 Design Basis

The design requirements for ozonation systems should be based on pilot testing or similar full-scale installations.

As a minimum, the following design factors should be considered:

a. Ozone dosage

b. Dispersion and mixing of ozone in wastewater

c. Contactor design

All design criteria shall be submitted upon request to justify the basis of design of the ozonation system. The detailed design requirements will be determined on a case-by-case basis.

10.4 Ultraviolet Light (UV)

10.4.1 Application

UV disinfection may be used for disinfection, particularly whenever chlorine availability, cost, or environmental benefits justify its application. For tertiary treatment plants where dechlorination is required or chlorine toxicity is suspected, UV disinfection is a viable alternative.

UV reactors can be configured as an open channel or closed vessel and with the lamps either submerged in the wastewater (while encased in a protective sleeve) or with the lamps surrounding the conduits transporting the wastewater.

10.4.2 Design Basis

10.4.2.1 General

Advantages of the use of UV include no residual toxicity, no reliance on chemicals or supply, improved safety and smaller footprint. Disadvantages include lack of residual disinfectant, increased energy cost and lamp maintenance.

10.4.2.2 Hydraulics

The approach channel and downstream channels must be designed to promote even flow distribution across the UV system, ensure submergence of the bulbs, sufficient exposure time, avoidance of backflow or excessive velocities.

10.4.2.3 Transmittance

The effluent should have a minimum 65% UV radiation transmittance at a wavelength of 254 nanometers and BOD and TSS concentrations of less than 30 mg/l.

10.4.2.4 Dosage

The minimum UV dosage should be based on the peak hourly flow and not be less than 30 mJ/cm^2 (after adjustments for quartz sleeve absorption, fouling and end of lamp life) for wastewaters meeting the characteristics described in 10.4.2.2.

Demonstrate that n+1 redundancy is provided for peak hour flows, where *n* may be a channel or bank depending on system design.

10.4.3 Equipment

10.4.3.1 Lamps

The lamps should be low pressure-low intensity, low pressure-high intensity or medium pressure-high intensity. Other technologies, such as LED, may be evaluated on a case-by-case basis.

10.4.3.2 Cleaning System

The performance of the UV system highly depends on the effectiveness of the cleaning system. Further, the system must be able to continue providing disinfection while maintaining the lamps, sleeves, and ballasts. The UV system should have an in-situ means of cleaning for routine operation or sufficient redundancy to allow removal and cleaning. Ensure ease of access for maintenance of the system.

10.4.3.3 Controls

A dedicated controller or programmable logic controller (PLC) should be provided. Multiple PLCs should be provided as necessary to ensure rapid recovery and minimize the deterioration of effluent quality from the failure of a single controller. An uninterruptable power supply with electrical surge protection shall be provided for each PLC to retain program memory (e.g., process control program, last known set-points and measured process/equipment status etc.) through a power loss. A hard-wired backup for manual override should be provided in addition to automatic process control. Both automatic and manual controls should allow independent operation of each UV disinfection unit.

10.4.4 Safety

An alarm system must be provided to notify of lamp failure, low UV intensity, transmittance, dose and any other causes of UV failure. Ease of maintenance and operator safety (to radiation exposure, electrical hazards, etc.) around the equipment must be considered in the design.

10.5 Peracetic Acid (PAA)

10.5.1 Application

Peracetic acid is typically sold as a solution ranging from 12 to 22 percent PAA. Design following pilot testing and toxicity studies should be manufacturer specific. The Division should be contacted for site specific considerations regarding the pilot and potential permitting requirements prior to implementation.

10.5.2 Design Basis

10.5.2.1 General

Similar to chlorine disinfection systems, the effectiveness is based on factors such as contact time, mixing and concentration of organisms. Some advantages of PAA over other methods are improved safety (than gaseous chlorine), long shelf life and potentially overall lower chemical usage. Disadvantages may include cost, availability, less historical performance data and resources.

10.5.2.2 Dosage

Typical dosing concentrations range from 1 mg/l to 10 mg/l. Flow proportional dosing is recommended. PAA can increase the BOD of the water and may need to be accounted for in the design.

10.5.2.3 Mixing

Mixing requirements should follow the guidance provided in section 10.2.2.3

10.5.2.3 Contact Time and Chambers

Contact time and basin design should generally follow the guidance provided in sections 10.2.2.4 and 10.2.2.5 unless pilot testing and manufacturer data provides otherwise.

10.5.2.4 Storage and Containers

Storage requirements should follow the manufacturer recommendations and the guidance provided in sections 10.2.4 and 10.2.5

10.5.2.5 Quenching

The maximum residual concentration will vary depending on site specific water quality requirements, however, it should not exceed 1 mg/l.

10.5.3 Equipment

Equipment considerations and requirements should follow manufacturer recommendations. Materials should be corrosion resistant. Special care should be given to retrofit projects.

10.5.4 Safety

Safety considerations and requirements should follow the guidance provided in section 10.2.6.

10.6 Alternate Methods

Other methods of disinfection such as chlorine dioxide, pasteurization, bromine chloride, etc.. may be considered on a case-by-case basis and/or through adequate pilot testing.

Appendix 10-A

Final Design Submission for Disinfection Projects Review Guidance- Checklist

WPN:	**Project Name:**

Acceptable	Item Number	Description	Comments
		General	
	1	Accurately completed Wastewater Plans Review Project submission form (myTDEC Forms)	
	2	Cover letter and/or plan signed by the utility representative and/or letter provided by the utility stating they approve the design and will own, operate and maintain the improvements	
	3	Fee received for the correct amount	
	4	All plan sheets sealed by a professional engineer licensed in TN, signed by owner; legible when printed on an 11x17 sheet	
	5	Calculations sealed by a professional engineer licensed in TN	
	6	Project cost	
	7	For chemical addition: adequate storage space, volumes, environmental protection and secondary containment	
	8	For chemical addition: feed equipment and injection location specified	
		Chlorination	
	9	Type of chlorine (gas, liquid or tablet)	
	10	Design Dosage (average and peak flows), preferably configured for flow proportional operation	
	11	Contact chamber L:W (30:1) ratio and contact time (30min avg, 15min peak)	
		Dechlorination	
	12	Type of dechlorination (e.g. SO_s, bisulfite, tablet)	
	13	Design Dosage (average and peak flows), preferably configured for flow proportional operation	
		Ultraviolet Light (UV)	
	14	Make, model and type of reactor	
	15	Flow conditioning provided	
	16	Transmittance specified (minimum 65% UVT at 254 nanometers and a BOD/TSS less than 30 mg/l)	

	17	Dosage based on peak hourly flow (minimum 30 mJ/cm^2)	
Peracetic Acid (PAA)			
	18	Results of pilot testing and/or Preliminary Project Discussion held with TDEC regarding site specific considerations	
	19	Design Dosage (average and peak flows), preferably configured for flow proportional operation	
	20	Contact Chamber, guidance for chlorine systems apply unless piloting data supports otherwise	
Safety			
	21	Alarms, leak detection, eye wash and other appropriate protective equipment identified on plans	

Appendix 10-B

Bibliography

Metcalf and Eddy (2014), Wastewater Engineering: Treatment and Resource Recovery, 5th Edition

National Water Research Institute (2012), Ultraviolet Disinfection: Guidelines for Drinking Water and Water Reuse, 3rd Edition

Oklahoma Department of Environmental Quality (2017), Peracetic Acid as a Disinfectant for Wastewater, (WQD-003)

Pennsylvania Department of Environmental Protection, Use of Chlorine Tablets for Wastewater Disinfection Fact Sheet.

US-EPA(2012) Alternative Disinfection Methods Fact Sheet, “Peracetic Acid”

US-EPA (1986), Design Manual Municipal Wastewater Disinfection, EPA/625/1-86/021

US-EPA (1977), Disinfection By Chlorination Design and Operation and Maintenance Guidelines, Region X, Seattle, Washington

US-EPA (2002), Small Onsite Wastewater Treatment Manual, EPA/625/R-00/008

US-EPA (2002), Use of Alternative Secondary Containment Measures at Facilities Regulated under the Oil Prevention Regulation Memorandum, OSWER 9360.8-38

Wastewater Committee of the Great Lakes—Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (2014)—Recommended Standards for Wastewater Facilities (Ten States Standards) Health Research, Inc. Albany, New York.

Water Environment Federation (2020), Peracetic Acid Disinfection-Implementation Considerations for Water Resource Recovery Facilities