LEGEND: **DRAFT 06/19/14**
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Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 20—Clean Water Commission
Chapter 8—Design Guides

10 CSR 20-8.190 Disinfection.

PURPOSE: The following criteria have been prepared as a guide for the design of disinfection facilities. This rule is to be used with rules 10 CSR 20-8.110[–] ***through*** *10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission [as]* ***in*** *regard[s]* ***to*** *adequacy of design, submission of plans, approval of plans****,*** *and approval of completed [sewage works.]* ***wastewater treatment facilities. It is not reasonable or practical to include all aspects of design in these standards. The design engineer should obtain appropriate reference materials which include but are not limited to: copies of all ASTM International standards pertaining to disinfection facilities and appurtenances, design manuals such as Water Environment Federation's Manuals of Practice, and other disinfection design manuals containing principles of accepted engineering practice.*** *Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria are taken largely from* ***the 2004 edition of the*** *Great Lakes-Upper Mississippi River Board of State [Sanitary Engineers]* ***and Provincial Public Health and Environmental Managers*** *Recommended Standards for [Sewage Works]* ***Wastewater Facilities*** *and are based on the best information presently available. These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. [Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.]*

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms **"**shall**"** and **"**must**"** are used, they are to mean a mandatory requirement insofar as approval by the *[agency]* **Missouri Department of Natural Resources (department)** is concerned, unless justification is presented for deviation from the requirements. Other terms, such as **"**should,**" "**recommend,**" "**preferred**,"** and the like, indicate *[discretionary requirements on the part of the agency and deviations are subject to individual consideration.]* **the preference of the department for consideration by the design engineer.**

(A) Deviations. Deviations from these rules may be approved by the department when engineering justification satisfactory to the department is provided. Justification must substantially demonstrate in writing and through calculations that a variation(s) from the design rules will result in either at least equivalent or improved effectiveness. Deviations are subject to case-by-case review with individual project consideration.

[(2) Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) (85.4 m^3) or less (see 10 CSR 20-8.020 for the

requirements for those facilities).]

(2) Applicability. This rule shall apply to all disinfection processes for wastewater treatment facilities. This rule shall supersede when there is a conflict with 10 CSR 20-8.020.

[(3) Forms of Disinfection. Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid chlorine and calcium or sodium hypochlorite. Other disinfectants, including chlorine dioxide, ozone or bromine, may be accepted by the agency in individual cases. The chemical should be selected after due consideration of waste flow rates, application and demand rates, pH of the wastewater, cost of equipment, chemical availability and maintenance problems. If chlorination is utilized, it may be necessary to dechlorinate if the chlorine level in the effluent would impair the natural aquatic habitat of the receiving stream.]

(3) General.

(A) Disinfection of the effluent shall be provided as necessary to meet applicable standards. The design shall consider meeting both the bacterial standards and the disinfection residual limit in the effluent. The disinfection process should be selected after due consideration of waste characteristics, type of treatment process provided prior to disinfection, waste flow rates, pH of waste, disinfection demand rates, current technology application, cost of equipment and chemicals, power cost, and maintenance requirements.

(B) If halogens are utilized, it may be necessary to dehalogenate if the residual level in the effluent exceeds effluent limitations or would impair the natural aquatic habitat of the receiving stream.

(C) Disinfection and dechlorination, where applicable, shall be provided during all power outages. For additional emergency power considerations, refer to 10 CSR 20-8.140(8)(A).

(D) Wastewater treatment facilities proposing disinfection for wet weather events shall be evaluated on a case-by-case basis.

(E) Where a disinfection process other than what is included in this rule is proposed, supporting data from pilot plant installations or similar full scale installations may be required as a basis for the design of the system. For additional new technology considerations, refer to 10 CSR 20-8.140(5)(B).

[(4) Feed Equipment.

(A) Type. Solution-feed vacuum-type chlorinators are generally preferred for large chlorination installations. The use of hypochlorite feeders of the positive displacement type may be considered and are generally preferred when intermittent disinfection is required. The preferred method of generation of chlorine dioxide is the injection of a sodium chlorite solution into the discharge line of a solution-feed gas-type chlorinator with subsequent formation of the chlorine dioxide in a reaction chamber at a pH of four (4.0) or less. Ozone dissolution is accomplished through the use of conventional gas diffusion equipment, with

appropriate consideration of materials. If ozone is being produced from air, gas preparation equipment (driers, filters, compressors) is required. If ozone is being produced from oxygen, this equipment may not be needed as a clean dry pressurized gas supply will be available.]

(B) Control.

1. Chlorination without dechlorination. Facilities with design flows of one million gallons per day (1.0 mgd) (3785 m^3/d) or greater shall be equipped with a chlorine rate control to feed the chlorine proportional to the flow of wastewater and the chlorine residual. Facilities with design flows between one (1.0) mgd (3785 m^3/d) and twenty-two thousand five hundred (22,500) gpd (85.4 m^3) should be equipped with a control system to feed the chlorine proportional to the flow of wastewater.

2. Chlorination with dechlorination. All facilities designed for dechlorination must be equipped to feed the chlorine proportional to the flow of wastewater and the chlorine residual. Dechlorination equipment shall be equipped to feed in proportion to the flow of wastewater.

3. Ozone. Facilities for disinfection with ozone should be equipped to feed the ozone in proportion to the flow of wastewater.]

(C) Capacity. Required disinfection capacity will vary, depending on the uses and points of application of the disinfecting chemical. For disinfection, the capacity should be adequate to produce an effluent that will meet the coliform limits specified by the agency. For normal domestic sewage, the following may be used as a guide in sizing chlorination facilities.

Type of Treatment	*Dosage*
Trickling filter plant	*10 mg/l*
Activated sludge plant effluent	*8 mg/l*
Tertiary filtration effluent	*6 mg/l*
Nitrified effluent	*6 mg/l*

(D)Standby Equipment and Spare Parts. Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts shall be available for all disinfection equipment to replace parts which are subject to wear and breakage.

(E) Water Supply. An ample supply of water shall be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided, and, when necessary, standby power as well. Protection of a potable water supply shall conform to the requirements of 10 CSR 20-8.140(8)(B).]

[(5) Chlorine Supply.

(A) General. The type of chlorine supply should be carefully evaluated during the planning process. Large quantities of chlorine are contained in ton cylinders and tank cars can present a considerable hazard to plant personnel and to the surrounding area should the containers develop leaks.

(B) Containers. The use of ton containers should be considered where the average daily chlorine consumption is over one hundred fifty pounds (150 lbs.) (68 kg). Both monetary cost and the potential residential exposure to chlorine should be considered when making the final determination.

(C) Tank Cars. At large chlorination installations consideration should be given to the use of tank cars, generally accompanied by gas evaporators. Both monetary cost and the potential residential exposure to chlorine should be considered when making the final determination. Liquid chlorine lines from tank cars to evaporators shall be buried and installed in a conduit and shall not enter below grade spaces. Systems shall be designed for the shortest possible pipe transportation of liquid chlorine.

(D) Scales. Scales for weighing cylinders shall be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. At least a platform scale shall be provided. Scales shall be of corrosion-resistant material.

(E) Evaporators. Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine, consideration should be given to the installation of evaporators, to produce the quantity of gas required.

(F) Leak Detection and Controls. A bottle of fifty-six percent (56%) ammonium hydroxide solution shall be available for detecting chlorine leaks. Where ton containers or tankcars are used, a leak repair kit approved by the Chlorine Institute shall be provided. Consideration should be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking ton containers where the containers are in use. At large chlorination installations, consideration should be given to the installation of automatic gas detection and related alarm equipment. For ozone installations, similar purpose equipment shall be provided.]

[(6) Ozone Generation. Ozone may be produced from either an air or an oxygen gas source. Generation units shall be automatically controlled to adjust ozone production to meet disinfection requirements.]

[(7) Piping and Connections. Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine or ozone service, with a minimum number of joints. Piping should be well supported and protected against temperature extremes. The correct weight or thickness of steel is suitable for use with dry chlorine liquid or gas. Even minute traces of water added to chlorine results in a corrosive attack that can only be resisted by pressure piping utilizing materials such as silver, gold, platinum or Hasteloy C. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinylchloride (PVC) or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine. Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine should be protected from the entrance of water or air containing water. For ozonation systems, the selection of material should be made with due consideration for ozone's corrosive nature. Copper or aluminum alloy should be avoided. Stainless steel with a corrosion resistance of at least equal to grade 304 L should be specified for piping containing ozone in nonsubmerged applications. Unplasticized PVC, Type 1, may be used in submerged piping, provided the gas temperature is below one hundred forty degrees Fahrenheit (140 °F) (60 °C) and the gas pressure is low.]

[(8) Housing.

(A) Separation. If gas chlorination equipment, chlorine cylinders or ozone generation equipment are to be in a building used for other purposes, a gas-tight room shall separate

this equipment from any other portion of the building. Floor drains from the chlorine room should not be connected to floor drains from other rooms. Doors to this room shall open only to the outside of the building and shall be equipped with panic hardware. The rooms shall be at ground level and should permit easy access to all equipment. Storage area should be separate from the feed area. Chlorination equipment should be situated as close to the application point as reasonably possible.

(B) Inspection Window. A clear glass, gas-tight window shall be installed in an exterior door or interior wall of the chlorinator or ozone generator room to permit the units to be viewed without entering the room.

(C) Heat. Rooms containing disinfection equipment shall be provided with a means of heating so that a temperature of at least sixty degrees Fahrenheit (60 °F) (16 °C) can be maintained but the room should be protected from excess heat. Cylinders shall be kept at essentially room temperature. The room containing the ozone generation units shall be maintained above thirty-five degrees Fahrenheit (35 °F) (2 °C) at all times.

(D) Ventilation. With chlorination systems, forced, mechanical ventilation shall be installed which will provide one (1) complete air change per minute when the room is occupied. For ozonation systems, continuous ventilation to provide at least six (6) complete air changes per hour should be installed. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas. Air inlets shall be so located as to provide cross ventilation with air and at a temperature that will not adversely affect the chlorination of ozone generation equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

(E) Electrical Controls. Switches for fans and lights shall be outside of the room at the entrance. A labeled signal light indicating fan operation should be provided at each entrance, if the fan can be controlled from more than more one (1) point.]

[(9) Respiratory Protection. Respiratory air-pac protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled and shall be stored at a convenient location but not inside any room where chlorine is used or stored. Instructions for using, testing and replacing mask parts including canisters, shall be posted adjacent to the equipment. The units shall use compressed air, have at least thirty (30)-minute capacity and be compatible with the units used by the fire department responsible for the plant.]

[(10) Application of Chlorine or Ozone.

(A) Mixing. The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in three (3) seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

(B) Contact Period. For a chlorination system, a minimum contact period of fifteen (15) minutes at peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing. Consideration should be given to running a field tracer study to assure adequate contact time. If dechlorination is required after complete mixing of the effluent with the chemical, no further contact time is necessary. The required contact time for an ozonation

unit varies with the type of dissolution equipment used. Certain high rate devices require contact times less than one (1) minute to achieve disinfection while conventional dissolution equipment may require contact times similar to chlorination systems.
(C) Contact Tank. The chlorine or ozone contact tank shall be constructed so as to reduce short-circuiting of flow to a practical minimum. Baffles shall be parallel to the longitudinal axis of the chamber with a minimum length to width ratio of forty to one (40:1) (the total length of the channel created by the baffles should be forty (40) times the distance between the baffles). The tank should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, mechanical scrapers or portable deck level vacuum cleaning equipment shall be provided. Consideration should be given to providing skimming devices on all contact tanks. Covered tanks are discouraged.]

[(11) Evaluation of Effectiveness.
(A) Sampling. Facilities shall be included for sampling the disinfected effluent after contact. In large installations, or where stream conditions warrant, provisions should be made for continuous monitoring of effluent chlorine residual.
(B) Testing. Equipment shall be provided for measuring chlorine residuals using accepted test procedures. Automatic equipment required by subsection (4)(C) of this rule may be used to meet the requirements of this subsection. Equipment shall also be required for measuring fecal coliform using accepted test procedures as required by 10 CSR 20-9.010.]

(4) Chlorine Disinfection.
(A) Type. Chlorine is available for disinfection in gas, liquid (hypochlorite solution), and solid (hypochlorite tablet) forms. The type of chlorine should be carefully evaluated during the facility planning process. The use of chlorine gas or liquid will be most dependent on the size of the facility and the chlorine dose required. Large quantities of chlorine, such as are contained in ton cylinders and tank cars, can present a considerable hazard to plant personnel and to the surrounding area should such containers develop leaks. Both monetary cost and the potential public exposure to chlorine should be considered when making the final determination. Facilities storing two thousand five hundred pounds of chlorine (2,500 lbs Cl_2) or greater must create a risk management plan in accordance with the Clean Air Act section 112(r).
(B) Dosage. For disinfection, the capacity shall be adequate to produce an effluent that will meet the applicable bacterial limits specified by the department for that installation. Required disinfection capacity will vary, depending on the uses and points of application of the disinfection chemical. The chlorination system shall be designed on a rational basis and calculations justifying the equipment sizing and number of units shall be submitted for the whole operating range of flow rates for the type of control to be used. System design considerations shall include the controlling wastewater flow meter (sensitivity and location), telemetering equipment and chlorination controls. For normal domestic wastewater, Table 1 may be used as a guide in sizing chlorination facilities.

Table 1 – Chlorine Dosages

Type of Treatment	Dosage
Lagoon effluent	**10 – 20 mg/L**
Trickling filter effluent	**10 mg/L**
Activated sludge effluent	**8 mg/L**
Tertiary filtration effluent	**6 mg/L**
Nitrified effluent	**6 mg/L**

(C) Containers.

1. Gaseous chlorine cylinders. One hundred fifty pound (150 lb) (68 kg) cylinders are typically used where chlorine gas consumption is less than one hundred fifty pounds per day (150 lbs/day) (68 kg/d). Cylinders must be stored in an upright position with adequate support brackets and chains at two thirds (2/3) of cylinder height for each cylinder.

2. Gaseous chlorine ton containers. The use of one (1)-ton (907 kg) containers should be considered where the average daily chlorine consumption is over one hundred fifty pounds (150 lb) (68 kg). For one (1)-ton containers provide the following:

A. A hoist with a two (2)-ton capacity; and

B. A monorail or hoist with sufficient lifting height to pass one (1) container over another.

3. Gaseous chlorine tank cars.

A. At large installations, the use of tank cars, generally accompanied by evaporators, may be considered. Area wide public safety shall be evaluated. No interruption of chlorination shall be permitted during tank car switching.

B. The tank car being used for the chlorine supply shall be located on a dead end, level track that is a private siding. The tank car shall be protected from accidental bumping by other railway cars by a locked derail device, a closed locked switch, or both. The area shall be clearly posted "DANGER - CHLORINE". The tank car shall be secured by adequate fencing that includes gates provided with locks for personnel and rail access.

C. The tank car site shall be provided with a suitable operating platform at the unloading point for easy access to the protective housing or the tank car for the connection of flexible feedlines and valve operation. Adequate area lighting shall be provided for night time operation and maintenance.

4. Liquid hypochlorite solutions.

A. Storage containers for hypochlorite solutions shall be of sturdy, non-metallic lined construction and shall be provided with secure tank tops and pressure relief and overflow piping.

B. The overflow piping should be provided with a water seal or other device to prevent tanks from venting to the indoors.

C. Storage tanks should be either located or vented outside.

D. Provision shall be made for adequate protection from light and extreme temperatures.

E. Tanks shall be located where leakage will not cause corrosion or damage to

other equipment.

F. Secondary containment shall meet the requirements of 10 CSR 20-8.140(10)(A)2.

G. Due to deterioration of hypochlorite solutions over time, it is recommended that containers not be sized to hold more than one (1) month's needs. At larger facilities and locations where delivery is not a problem, it may be desirable to limit on-site storage to one (1) week.

H. For additional housing considerations, refer to 10 CSR 20-8.140(10)(B).

I. For additional safety considerations, refer to 10 CSR 20-8.140(9).

5. Dry hypochlorite compounds.

A. Dry hypochlorite compounds (tablets) should be kept in tightly closed containers and stored in a cool, dry location.

B. Some means of dust control should be considered, depending on the size of the facility and the quantity of compound used.

C. For additional housing considerations, refer to 10 CSR 20-8.140(10)(B).

D. For additional safety considerations, refer to 10 CSR 20-8.140(9).

(D) Equipment.

1. Scales. Scales for weighing cylinders and containers shall be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. At a minimum, a platform scale shall be provided. Scales shall be of corrosion-resistant materials.

2. Evaporators. Evaporators must be considered to produce the quantity of gas required where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine.

3. Automatic switchovers. Automatic gas container or liquid chlorine tank changeover must be provided.

4. Flow pacing. All chlorination systems must consider pacing chlorine dose according to flow and chlorine residual. If used, flow control must be from effluent flow meters and placement of residual analyzer probe must ensure appropriate lag time for residual analyzer control.

5. Mixing. The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being achieved in three (3) seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

6. Contact period and tank.

A. For a chlorination system, a minimum contact period of fifteen (15) minutes at design peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing. When evaluating existing chlorine contact tanks, field tracer studies should be performed to assure adequate contact time.

B. The chlorine contact tank shall be constructed so as to reduce short-circuiting of flow to a practical minimum. Tanks not provided with continuous mixing shall be provided with "over-and-under" or "end-around" baffling to minimize short-circuiting. Baffles shall be parallel to the longitudinal axis of the chamber with a minimum length to width ratio of forty to one (40:1) (the total length of the channel created by the baffles should be forty (40) times the distance

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between the baffles), unless adequate mixing is provided.

C. The tank should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, mechanical scrapers, or portable deck-level vacuum cleaning equipment should be provided. Consideration should be given to providing skimming devices on all contact tanks.

D. Covered tanks are discouraged.

7. Piping and connections.

A. Piping materials shall be specifically selected and manufactured to be suitable for chlorine gas. Piping systems should be as simple as possible with a minimum number of joints. Piping should be well supported and protected against temperature extremes.

B. Due to the corrosiveness of wet chlorine, all lines designated to handle dry chlorine shall be protected from the entrance of water or air containing water. Even minute traces of water added to chlorine results in a corrosive attack. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinyl chloride, or other approved materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

C. Where sulfur dioxide is used, the piping and fittings for chlorine and sulfur dioxide systems shall be designed so that interconnection between the two (2) systems cannot occur.

D. The chlorine system piping shall be color coded and labeled to distinguish it from other plant piping. For additional painting information, refer to 10 CSR 20-8.140(6)(E).

8. Standby equipment and spare parts. Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts shall be available for all disinfection equipment to replace all parts subject to wear and breakage.

9. Chlorinator water supply. An ample supply of water shall be available for operating the chlorinator. Where a booster pump is utilized, duplicate equipment should be provided. Protection of potable water supply shall conform to the requirements of 10 CSR 20-8.140(8)(D). Adequately filtered plant effluent should be considered for use in the chlorinator.

10. Leak detection and controls.

A. Ammonium hydroxide solution shall be available for detecting chlorine leaks.

B. Where one (1)-ton (907 kg) containers or tank cars are used, a leak repair kit approved by the Chlorine Institute shall be provided.

C. Consideration should be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking one (1)-ton (907 kg) containers where such containers are in use.

D. Consideration should be given to the installation of automatic gas detection and related alarm equipment.

(E) Gaseous Chlorine Housing.

1. Feed and storage rooms.

A. Chlorine gas feed and storage rooms shall be constructed of fire and corrosion resistant material.

B. If gas chlorination equipment or chlorine cylinders are to be in a building used for other purposes, a gas-tight room shall separate this equipment from any other portion of the building.

C. Floor surfaces shall be smooth, impervious, and slip-proof. Floor drains are discouraged. Where provided, the floor drains shall be plugged or sealed.

D. Doors to this room shall open only to the outside of the building, and shall be equipped with panic hardware. Doors shall lock to prevent unauthorized access, but do not need a key to exit the locked room using the panic hardware.

E. Rooms shall be well-lighted with lights that are sealed so that they will continue working during a chlorine leak. The lights and electrical equipment shall comply with the National Electrical Code requirements for Class I, Division 2 locations.

F. Rooms shall be at ground level and should permit easy access to all equipment.

G. Storage areas for one (1)-ton (907 kg) cylinders should be separated from the feed area.

H. The storage area shall have designated areas for "full" and "empty" cylinders.

I. Chlorination equipment should be situated as close to the application point as reasonably possible.

2. Inspection window. A clear glass, gas-tight, and shatter resistant window shall be installed in an exterior door or interior wall of the chlorination room to permit the units to be viewed without entering the room. The feeder settings and scale readings should be easily read from the inspection window or remotely read in a separate control room.

3. Heat.

A. Rooms containing disinfection equipment shall be provided with a means of heating so that a temperature of at least sixty degrees Fahrenheit (60° F) (16° C) can be maintained.

B. The room should be protected from excess heat.

C. Cylinders shall be kept at essentially room temperature. Cylinders and gas lines should be maintained at the same temperature as the feed equipment.

D. Equipment used to heat a chlorine storage or feed area shall be located a safe distance from, and shall not blow directly onto, chlorine cylinders.

E. Heating or air conditioning equipment provided shall be separate from central heating and air conditioning systems to prevent chlorine gas from entering the central system. Central heating or cooling ducts shall not terminate or pass through a chlorine room.

4. Ventilation.

A. Forced, mechanical ventilation shall be installed with chlorination systems in order to provide one (1) complete fresh air change per minute when the room is occupied. The fans shall be constructed of chemical resistant materials and have

chemical proof motors. Squirrel cage type fans located outside the chlorine room(s) may be approved if their fan housings and ducting are airtight and made of chlorine and corrosion resistant material.

B. The entrance to the air exhaust duct from the room shall be no more than twelve inches (12") (30.5 cm) off the floor. The point of discharge shall be so located as not to contaminate the air inlet to any buildings or present a hazard at the access to the chlorinator room or other inhabited areas. Louvers for air exhaust shall facilitate airtight closure.

C. Air inlets shall be so located as to provide cross ventilation with air and at such a temperature as to not adversely affect the chlorination equipment. The outside air inlet shall be at least three feet (3') (0.9 m) above grade. Louvers for air inlets shall facilitate airtight closure.

D. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade. Vents shall be screened.

E. Where public exposure may be extensive, scrubbers may be required on ventilation discharge.

5. Electrical controls. Switches for fans and lights shall be outside of the chlorine room at the entrance. A labeled signal light indicating fan operation should be provided at each entrance, if the fan can be controlled from more than one (1) point.

6. Ambient gas detectors. An ambient chlorine gas detector should be provided in the chlorine storage room. The gas detector should be interlocked with the fan and alarm system. <u>The alarm system shall conform to subsection (4)(F) of this rule.</u>

7. Protective and respiratory gear. Respiratory air-pac protection equipment, that meet the requirements of the National Institute for Occupational Safety and Health (NIOSH), shall be available where chlorine gas is handled, and shall be stored at a convenient location, but not inside any room where chlorine is used or stored. Instructions for using the equipment shall be posted. The units shall use compressed air, have at least thirty (30)-minute capacity and be compatible with the units used by the fire department responsible for the treatment facility. For additional safety considerations, refer to 10 CSR 20-8.140(9).

(F)Alarm System. A chlorine system must include an alarm system.

1. The alarm system shall conform with the requirements of 10 CSR 20-8.140(8)(C).

2. The applicant shall be responsible for specifying what the alarm requirements need to be in order to assure consistent disinfection in compliance with the applicable bacteria limits.

(G) Sampling and Control.

1. Sampling. Facilities shall be included for sampling disinfected effluent, including at least one (1) point downstream of the contact chamber which may be the same as the point of compliance. In large installations, or where stream conditions warrant, provisions should be made for continuous monitoring of the effluent chlorine residual. Sampling points must be identified. For additional sampling considerations, refer to 10 CSR 20-8.140(7)(C).

2. Testing and control. Equipment shall be provided for measuring chlorine residual using accepted test procedures. The installation of demonstrated effective

facilities for automatic chlorine residual analysis, recording, and proportioning systems should be considered at all large installations.

(5) Dechlorination.

(A) Types.

1. Dechlorination of wastewater effluent may be necessary to reduce the toxicity due to chlorine residuals. The most common dechlorination chemicals are sulfur compounds, particularly sulfur dioxide gas or aqueous solutions of sulfite or bisulfite. Solid (tablet) dechlorination systems are also available for small facilities.

2. The type of dechlorination system should be carefully selected considering criteria including: type of chemical storage required, amount of chemical needed, ease of operation, compatibility with existing equipment, and safety.

(B) Dosage.

1. The dosage of dechlorination chemical should depend on the residual chlorine in the effluent, the final residual chlorine limit, and the particular form of dechlorinating chemical used. The most common dechlorination agent is sulfite (SO_2). The following forms as shown in Table 2 of the compound are commonly used and yield sulfite when dissolved in water.

Table 2 – Dechlorination Dosages

Dechlorination Chemical	Theoretical mg/L Required to Neutralize 1 mg/L Cl_2
Sodium thiosulfate (solution)	0.56
Sodium sulfite (tablet)	1.78
Sulfur dioxide (gas)	0.90
Sodium meta bisulfite (solution)	1.34
Sodium bisulfite (solution)	1.46
Calcium thiosulfate (solution)	0.99
Ascorbic acid (solution)	2.50

2. Theoretical values may be used for initial approximations, to size feed equipment with the consideration that under good mixing conditions ten percent (10%) excess dechlorinating chemical is required above theoretical values. Excess sulfur dioxide may consume oxygen at a maximum of one milligram (1 mg) dissolved oxygen for every four milligrams sulfite (4 mg SO_2).

3. The liquid solutions come in various strengths. These solutions may need to be further diluted to provide the proper dose of sulfite.

(C) Containers. Depending on the chemical selected for dechlorination, the storage containers will vary from gas cylinders, liquid in fifty gallon (50 gal) (190 L) drums or dry compounds. Dilution tanks and mixing tanks are required when using dry compounds and may be required when using liquid compounds to deliver the proper dosage. Solution containers should be covered to prevent evaporation and spills. Secondary containment shall meet the requirements of 10 CSR 20-8.140(10)(A)2.

(D) Feed Equipment, Mixing, and Contact Requirements.

1. Equipment.

A. In general, the same type of feeding equipment used for chlorine gas may be used with minor modifications for sulfur dioxide gas. However, the manufacturer should be contacted for specific equipment recommendations. No equipment should be alternately used for the two (2) gases. The common type of dechlorination feed equipment utilizing sulfur compounds include a vacuum solution feed of sulfur dioxide gas and a positive displacement pump for aqueous solutions of sulfite or bisulfite.

B. The selection of the type of feed equipment utilizing sulfur compounds shall include consideration of the operator safety and overall public safety relative to the wastewater treatment facility's proximity to populated areas and the security of gas cylinder storage. The selection and design of sulfur dioxide feeding equipment shall take into account that the gas reliquifies quite easily. Special precautions shall be taken when using one (1)-ton (907 kg) containers to prevent reliquefaction.

C. Where necessary to meet the operating ranges, multiple units shall be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the dissolved oxygen concentrations in the receiving waters.

2. Mixing requirements. The dechlorination reaction with free or combined chlorine will generally occur within fifteen to twenty (15 – 20) seconds. The dechlorination chemical should be introduced at a point in the process where the hydraulic turbulence is adequate to assure thorough and complete mixing. If no such point exists, mechanical mixing shall be provided. The high solubility of sulfite prevents it from escaping during turbulence.

3. Contact time. A minimum of thirty (30) seconds for mixing and contact time shall be provided at the design peak hourly flow or maximum rate of pumpage. A suitable sampling point shall be provided downstream of the contact zone. Consideration shall be given to a means of reaeration to assure maintenance of an acceptable dissolved oxygen concentration in the stream following sulfonation.

4. Standby equipment and spare parts. The same requirements apply as for chlorination systems. See paragraph (4)(D)8. of this rule.

5. Sulfonator water supply. The same requirements apply as for chlorination systems. See paragraph (4)(D)9. of this rule.

(E) Housing Requirements.

1. Feed and storage rooms.

A. The requirements for housing sulfite gas equipment shall follow the same guidelines as for chlorine gas. Refer to subsection (4)(E) of this rule for specific details.

B. The mixing, storage, and solution delivery areas shall be designed to contain or route solution spillage or leakage away from traffic areas to an appropriate containment unit. Secondary containment shall meet the requirements of 10 CSR 20-8.140(10)(A)2.

2. Protective and respiratory gear. The respiratory air-pac protection equipment is

the same as for chlorine. See paragraph (4)(E)6. of this rule. Leak repair kits of the type used for chlorine gas that are equipped with gasket material suitable for service with sulfur dioxide gas may be used. For additional safety considerations, refer to 10 CSR 20-8.140(9).

(F)Alarm System. A dechlorination system must include an alarm system.

1. The alarm system shall conform with the requirements of 10 CSR 20-8.140(8)(C).

2. The applicant shall be responsible for specifying what the alarm requirements need to be in order to assure consistent dechlorination in compliance with the applicable residual chlorine limits.

(G) Sampling and Control.

1. Sampling. Facilities shall be included for sampling the dechlorinated effluent for residual chlorine, including at least one (1) point downstream of the dechlorination system which may be the same sampling point as paragraph (4)(G)1. of this rule. Provisions shall be made to monitor for dissolved oxygen concentration after sulfonation when required by the department. Sampling points must be identified. For additional sampling considerations refer to 10 CSR 20-8.140(7)(C).

2. Testing and control. Provision shall be made for manual or automatic control of sulfonator feed rates based on chlorine residual measurement or flow.

(6) Ultraviolet Disinfection.

(A) Expected performance of the ultraviolet (UV) disinfection units <u>for the full operating range of flow rates</u> shall be based upon experience at similar full scale installations or thoroughly documented prototype testing with the particular wastewater. Critical parameters for UV <u>disinfection</u> units are dependent upon manufacturers' design, lamp selection, tube materials, ballasts, configuration, control systems, and associated appurtenances.

(B) Dosage and System Sizing.

1. General. The UV dosage shall be based on the larger of the design peak hourly flow, maximum rate of pumpage, or peak batch flow.

2. Batch discharges. Wastewater treatment facilities with batch discharges, such as sequencing batch reactors, should consider the following:

A. The need for flow equalization prior to the UV system in order to maintain continuous operation;

B. If no flow equalization is provided for a batch discharger, the dosage shall be based on the peak batch flow; and

C. The UV system should be designed to have their power cycled up to the maximum number of batches per day to accommodate the batch discharges.

3. Bioassay. An independent, third party bioassay shall be used to verify the design UV requirements. The UV system shall deliver the target dosage based on the equipment's derating factors. If needed, the UV equipment manufacturer shall verify that the scale up or scale down factor utilized in the design is appropriate for the specific application under consideration. The bioassay report shall be available upon request by the department. The independent, third party engineer's imprint of his/her registration seal with the date and engineer's signature shall be affixed to

the bioassay report.

4. New wastewater treatment facilities. The design delivered UV dosage for a new wastewater treatment facility shall be a minimum of thirty thousand microwatt seconds per centimeters squared (30,000 µW • s/cm^2) based on MS-2 phage inactivation. This dosage is to be delivered assuming a high quality effluent having at least sixty-five percent (65%) ultraviolet radiation transmittance (UVT) at two hundred fifty-four nanometers (254 nm) wave length.

A. The use of a lower bioassay dose based on a different organism in similar water quality will be considered upon submittal of the bioassay to the department in accordance with paragraph (6)(B)3. of this rule.

5. Existing wastewater treatment facilities. Existing wastewater treatment facilities must determine the UVT by testing the effluent's UVT a minimum of once per week over a one (1) month period. The applicant shall present the UVT test results and determined UV dosage to the department.

A. If a wastewater treatment facility does not conduct UVT testing, the default criteria in paragraph (6)(B)4. of this rule shall be utilized for design.

B. Wastewater treatment facilities utilizing fixed film or lagoon treatment processes must conduct the UVT testing in accordance with paragraph (6)(B)5. of this rule, due to the assumed lower effluent quality.

(C) Design.

1. Definitions.

A. Module – A grouping of ultraviolet lamps electrically and physically connected to each other.

B. Bank – A grouping of modules that -

(I) Forms a complete unit capable of treating the full channel design width and depth;

(II) Light output can be automatically adjusted or turned ON/OFF in relation to effluent flow variations; and

(III) Is electrically or physically connected together or physically adjacent to each other.

C. Open channel. Open channel designs are comprised of modules and banks. In order to provide maintenance, modules may be removed without interrupting service to the remaining modules and banks on-line.

D. Closed vessel. Closed vessel designs consist of UV lamps fully enclosed in a conduit with the waste flow. In order to provide maintenance, closed vessel systems must be taken off-line and removed in entirety.

2. Redundancy and configuration.

A. Open channel systems. At least two (2) banks shall be provided for disinfection reliability and to ensure service during lamp cleaning or other required maintenance.

(I) Facilities must be capable of treating the design average flow with one (1) bank out of service.

(II) The combination of the total number of banks shall be capable of treating the peak hourly flow.

Text to be *[deleted]* is in italics and bracketed.
Black bold text is added from the 2004 & 2014 version of the 10 States Standards, Chapter 100.
Orange bold text is added for clarification and agreed upon by the department.
Underline text is added from the previous Stakeholder meeting on May 21, 2014.

(III) Facilities with a design flow of less than one hundred thousand (100,000) gallons (378.5 m^3) per day and have seasonal bacterial effluent limits are only required to have one (1) bank. At least one (1) spare module shall be stored for maintenance.

B. Closed vessel systems. At least two (2) closed vessels shall be provided for disinfection reliability and to ensure service during lamp cleaning or other required maintenance.

(I) Facilities must be capable of treating the design average flow with one (1) closed vessel out of service.

(II) The combination of the total number of closed vessels shall be capable of treating the peak hourly flow.

3. Open channel system hydraulics.

A. The approach channel must be unobstructed and without bends to prevent jetting and short circuiting of the UV system.

B. If the lamps are immersed directly in the waste flow, water level control must be provided to achieve the necessary exposure and ensure that the UV lamps remain submerged at a near-constant depth, regardless of flow. Each UV bank should also have a water level sensor and a safety interlock that automatically shuts off the effected bank if a low-water level is measured.

C. The downstream channel length must be unobstructed following the last bank of UV lamps and before a fluid-level control device.

4. Closed vessel system hydraulics. The hydraulic properties of the system shall be designed to simulate plug flow conditions under the full operating flow range.

5. The upstream and downstream portions of a UV system should be covered to shut out all natural light in order to prevent algae growth.

6. The design shall allow for each bank or closed vessel to be removed from service independently to facilitate maintenance.

7. Measures shall be provided to dewater each channel or closed vessel.

8. A means of lifting the UV system to facilitate maintenance and lamp cleaning should be provided.

9. Cleaning. The cleaning system must be capable of removing a scale or grease buildup without disassembling the UV system.

A. Automatic cleaning systems are strongly recommended.

B. If an automatic cleaning system consists only of a mechanical cleaning component, chemical cleaning should also be provided.

C. Closed vessel systems utilizing medium-pressure lamps shall be provided with an automatic cleaning system in order to prevent algae growth.

(D) Monitoring and Alarms.

1. An ultraviolet system shall continuously monitor and display at the UV system control panel the following:

A. The relative intensity of each bank or closed vessel system;

B. The operational status and condition of each bank or closed vessel system;

C. The ON/OFF status of each lamp in the system; and

D. The total number of operating hours of each bank or each closed vessel

system.

2. A UV system must include an alarm system.

A. The alarm system shall conform with the requirements of 10 CSR 20-8.140(8)(C).

B. The UV alarm system must activate in the following minimum conditions:

(I) The relative UV intensity of the original lamp output of the system is reduced to less than forty-five percent (45%); or

(II) More than ten percent (10%) of the lamps fail; or

(III) There is an outage of any module, bank, or closed vessel system.

(E) Spare Parts. An adequate available supply of spare parts must be provided. A minimum number of spare parts recommended include the following:

1. Two (2) UV lamps;

2. One (1) lamp sleeve;

3. Two (2) O-ring seals; and

4. One (1) ballast.

(F) Electrical Controls. The electrical controls shall conform with the requirements of 10 CSR 20-8.140(8)(B).

(G) Sampling Points. Facilities shall be included for sampling the disinfected effluent, including at least one (1) point downstream of the UV system which may be the same as the point of compliance. Sampling points must be identified. For additional sampling considerations refer to 10 CSR 20-8.140(7)(C).

(H) System Safety.

1. Operator safety (electrical hazards and exposure to UV radiation) and lamp cleaning frequency shall be provided for.

2. Personal protective safety equipment, including a UV rated face shield and safety glasses or goggles must be readily available to personnel.

3. For additional safety considerations, refer to 10 CSR 20-8.140(9).

(7) Peracetic Acid. Peracetic acid (PAA) is a strong oxidizing agent used for disinfection. PAA is primarily comprised of glacial acetic acid, water, and hydrogen peroxide.

(A) Dosage. For disinfection, the capacity shall be adequate to produce an effluent that will meet the applicable bacterial limits and PAA effluent residual specified by the department for that installation.

1. The minimum PAA dose shall be one part per million (1.0 ppm).

2. Required disinfection capacity will vary, depending on the uses and PAA points of application.

3. The PAA system shall be designed on a rational basis and calculations justifying the equipment sizing and number of units shall be submitted for the whole operating range of flow rates for the type of control to be used.

4. The PAA dose shall be flow paced.

(B) Containers. Storage containers for PAA shall be of sturdy, non-corrosive material construction and shall be provided with a secure top.

1. Chemicals for use in PAA disinfection should be kept upright, in their original shipping containers with hazard labels intact. Stacking of PAA chemical containers

is prohibited.

2. Bulk on-site storage shall be provided with pressure relief and overflow piping. The overflow piping should be comprised of a water seal or other device to prevent venting to the indoors.

3. Secondary containment shall meet the requirements of 10 CSR 20-8.140(10)(A)2.

(C) Housing.

1. The storage room should be kept separate from all other processes and should be separated from acids, alkalies, organic materials, and heavy metals.

2. Temperatures above eighty-six degrees Fahrenheit (86° F) (30° C) and below forty degrees Fahrenheit (40° F) (4° C) should be avoided.

3. Space for at least one (1) months' supply of PAA should be available.

4. For additional housing considerations, refer to 10 CSR 20-8.140(10)(B).

(D) Leak Detection. Leak detecting equipment must be located near chemicals and near valves and equipment that pose a potential threat.

(E) Piping and Connections. Manufacturer approved compatible piping and connections shall be used. PAA piping shall be color coded and labeled to distinguish it from other plant piping. For additional painting considerations, refer to 10 CSR 20-8.140(6)(E).

(F) Mixing. The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in three (3) seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

(G) Contact Period and <u>Reactor</u>.

1. A minimum contact period of ten (10) minutes at design peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing. For evaluation of existing contact <u>reactors</u>, field tracer studies should be done to assure adequate contact time.

2. The contact <u>reactor</u> shall be so constructed so as to reduce short-circuiting of flow to a practical minimum. <u>Reactors</u> not provided with continuous mixing shall be provided with "over-and-under" or "end-around" baffling.

3. <u>Reactors</u> should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection.

(H) Alarm System. A PAA system must include an alarm system.

1. The alarm system shall conform with the requirements of 10 CSR 20-8.140(8)(C).

2. The applicant shall be responsible for specifying what the alarm requirements need to be in order to assure consistent disinfection in compliance with the applicable bacteria limits.

(I) Standby Equipment and Spare Parts. Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts shall be available for all disinfection equipment to replace parts which are subject to wear and breakage.

(J) Sampling. Facilities shall be included for sampling the disinfected effluent, including at least one (1) point downstream of the PAA contact tank which may be the same as the point of compliance. Sampling points must be identified. For additional sampling considerations refer to 10 CSR 20-8.140(7)(C).

(K) Safety. Personal protective safety equipment, including goggles, protective clothing, gloves, and a respirator must be readily available to personnel. Respiratory air-pac protection equipment, meeting the requirements of NIOSH shall be stored at a convenient location, but not inside any room where PAA is used or stored. Instructions for using the equipment shall be posted. The units shall use compressed air, having at least thirty (30)-minute capacity and be compatible with the units used by the fire department responsible for the treatment facility. For additional safety considerations, refer to 10 CSR 20-8.140(9).

(8) Membrane Bioreactors (MBR). MBRs utilizing membranes with a pore size no larger than four tenths microns (0.40 µm) is a proven and acceptable means of wastewater disinfection.

(9) Ozone. Ozone gas is a proven and acceptable means of wastewater disinfection. Historically, however, only limited use has been made of ozone for wastewater disinfection, both in Missouri and the United States as a whole. Ozone systems for disinfection should be evaluated on a case-by-case basis. Design standards, operating data, and experience for this process are not well established. Therefore, design of these systems should be based upon experience at similar full scale installations or thoroughly documented prototype testing with the particular wastewater.

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**Original authority 1972, amended 1973, 1987, 1993.*