CHAPTER 90
DISINFECTION

91. FORMS OF DISINFECTION

___ Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid (gas) chlorine, solid powdered calcium hypochlorite and liquid sodium hypochlorite. Moist chlorine gas is very corrosive, an irritant, causes blistering, and will support combustion. Calcium hypochlorite is a corrosive and rapid oxidant, unstable and combustible. It may react explosively with common substances, such as petroleum products. It is typically used in strengths of 60% to 65%. It may emit chlorine gas. Sodium hypochlorite is an unstable corrosive, typically used in strengths of 53% to 15%. It may also emit chlorine gas. Other disinfectants, including chlorine dioxide, ozone, bromine, or ultraviolet disinfection may be accepted by the Department in individual cases. When chlorinating, it may be necessary to dechlorinate.

92. FEED EQUIPMENT

92.1 Type

___ Solution-feed vacuum-type chlorinators are generally preferred for large chlorination installations. The use of tablet chlorinators may be considered and are generally preferred when disinfection at smaller facilities is required. The preferred method of generation of chlorine dioxide is the injection of a sodium hypochlorite solution into the discharge line of a solution-feed gas-type chlorinator.

___ Ozone dissolution is accomplished through with conventional gas diffusion equipment, with appropriate consideration of materials. If ozone is being produced from air, rather than oxygen, gas preparation equipment (driers, filters, compressors) is required.

92.2 Capacity

___ For normal domestic sewage, the following may be used as guide in sizing chlorination facilities.

Type of Treatment	Dosage
Trickling filter plant effluent	10 mg/1
Activated sludge plant effluent	8 mg/1
Tertiary filtration effluent	6 mg/1
Nitrified effluent	6 mg/1

92.3 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 that are subject to wear and breakage.

92.4 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 supply shall conform to the requirements of Section 46.2.

93. CHLORINE SUPPLY

93.1 Containers

___ The use of ton containers should be considered where the average daily chlorine consumption is over 150 pounds (68 kg).

___ In all cases, all chlorine bottles or containers shall always be properly chained or secured and supported to prevent movement, accidents, and leaks.

93.2 Tank Cars

___ At large chlorination installations, consideration should be given to the use of tank cars, generally accompanied by evaporators. 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.

93.3 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.

93.4 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.

93.5 Leak Detection and Controls for Gas Systems

A bottle of 56% ammonium hydroxide solution shall be available for detecting chlorine leaks. Where ton containers or tank cars 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 containers. 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.

94. 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.

95. PIPING AND CONNECTIONS

___ Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for corrosive chlorine or ozone service. Piping should be well supported and protected against temperature extremes.

___ All lines designed to handle dry chlorine shall be protected from the entrance of water or air containing water. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinyl chloride (PVC), or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

___ For ozonation systems, copper or aluminum alloys should be avoided. Only materials at least as corrosion-resistant to ozone as Grade 304 L stainless steel should be specified for piping containing ozone in nonsubmerged applications. Unplasticized PVC, Type I, may be used in submerged piping, provided the gas temperature is below 140EF (60EC) and the gas pressure is low.

96. HOUSING

96.1 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 shall 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. Such rooms shall be at ground level, and should permit easy access to all equipment. Storage area should be separated from the feed area. Chlorination equipment should be situated as closed to the application point as reasonably possible.

96.2 Inspection Window

___ A clear glass, gas-tight window shall be installed in a door or wall of the chlorinator or ozone generator room to permit the units to be viewed without entering the room.

96.3 Heat

___ Rooms containing disinfection equipment shall be provided with a means of heating so that a temperature of at least 60EF (16EC) can be maintained. The room should be protected from excess heat. Cylinders shall be kept at essentially room temperature. The room containing the ozone generation units shall always be maintained above 35EF (2EC).

96.4 Ventilation

___ With chlorination systems, forced mechanical ventilation shall be installed which will provide one complete air change per minute when the room is occupied. For ozonation systems, continuous ventilation to provide at least 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 such temperature that will not adversely affect the chlorination or ozone generation equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

96.5 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 one point.

97. 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 the equipment shall be posted. The units shall use compressed air, have at least 30-minute capacity, and be compatible with the units used by the fire department responsible for the plant.

98. APPLICATION OF CHLORINE OR OZONE

98.1 Mixing

___ The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in 3 seconds. This may be accomplished by the use of turbulent flow regime, a mechanical flash mixer, or diffused post-aeration.

98.2 Contact Period

___ For a chlorination system, a minimum contact period of 15 minutes at peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing. If dechlorination is required, no contact time is necessary after complete mixing (30 seconds, minimum) of the effluent with the chemical. The required contact time for an ozonation unit varies with the type of dissolving equipment used.

98.3 Contact Tank

___ The chlorine or ozone contact tank shall be constructed so as to reduce short-circuiting of flow to a practical minimum. "Over-and-under" or "around-end" baffling shall be provided to minimize short-circuiting.

___ 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. Covered tanks are discouraged.

99. EVALUATION OF EFFECTIVENESS

99.1 Sampling

___ Facilities shall be included for sampling the disinfected effluent after contact. In large installations, or where stream conditions warrant, provision should be made for continuous monitoring of effluent residual.

99.2 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 installations.

99A. DECHLORINATION

Dechlorination may be accomplished using sulfur dioxide (SO_2) or other chemicals.

___ There must be no possibility of contact between chlorine gas and sulfur dioxide gas.

___ The housing requirements are generally the same as the chlorine (Section 96). The dechlorination system should be in a separate building from the chlorination system. If in the same enclosed building, the chlorination and dechlorination systems shall be in separate gas-tight rooms.

___ If any valves, fittings, pressure gauges, etc. will fit both the chlorination and dechlorination systems, they shall be color coded to prevent cross connections. Preferably, fittings, gauges, etc. will be sized or reverse threaded such that cross connections are impossible.

___ Respiratory equipment shall be available as described in Section 97.

___ Facilities that dechlorinate shall post-aerate as described in Section 115.

99B. ULTRAVIOLET DISINFECTION

99B.1 Introduction

___ Ultraviolet light can effectively disinfect wastewater that has low suspended solids level. Ultraviolet light shall not be used to disinfect wastewater that has a suspended solids level higher than 30 mg/1 and should not be used to disinfect wastewater that has a suspended solids level higher than 15 mg/l.

99B.2 References

___ Ultraviolet disinfection systems shall be designed according to:

a. Wastewater Disinfection (1986)
Water Pollution Control Federation Manual of Practice FD-10.
b. Municipal Wastewater Disinfection (1986) EPA/625/1-86-021
c. Other appropriate references.