1 General

1.1 Purpose

The purpose of this Standard is to establish minimum performance requirements for disinfection devices used in treating, recycling, reusing, or disposal of wastewater from residential or commercial treatment systems. This Standard is intended to protect public health and the environment as well as to minimize nuisance factors.

1.2 Scope

This Standard is intended for use with devices intended to disinfect wastewater after secondary treatment and prior to discharge from residential wastewater treatment systems having rated treatment capacities between 757 L/day (200 gal/day) and 5678 L/day (1500 gal/day) or commercial wastewater treatment systems having a rated treatment capacity exceeding 5678 L/day (1500 gal/day). This Standard also applies to devices intended to be used in water reclamation and reuse. Specific requirements exist for construction and testing of individual disinfection devices based on the specific technology used by the device. All Devices are required to be tested against the influent challenge water as specified in section 1.4 and to meet the minimum effluent quality requirements in accordance with 1.5. Devices shall be tested against the effluent requirements of this Standard unless the manufacturer requests certification under an effluent standard in NSF/ANSI 350 which is more stringent than this Standard.

1.3 Alternative materials, design, and construction

When specific materials, design, and construction are stipulated in this Standard, devices that incorporate alternate materials, designs, or constructions are acceptable when it is verified that such systems meet the applicable requirements. All such alternative material and methods and all stipulated materials and methods shall be subject to a life test or chemical resistance test as specified in this Standard for the particular technology.

1.4 Influent water characteristics

Test data collected on days when the influent water pH and temperature are out of compliance with this section shall be excluded from the results. Any results from days where CBOD₅, TSS, fecal coliform, or ammonia influent concentration is less than shown in the table below shall be excluded. Any results from days where UV transmittance is greater than 75% shall be excluded. The manufacturer should include results obtained when other influent concentrations exceed the maximum values in the table below for the influent water. Influent water for the biological deactivation testing shall be secondary treated residential wastewater meeting the following criteria.

NOTE – At the manufacturer’s discretion, any data collected on days when the influent CBOD₅, TSS, fecal coliform, or ammonia concentrations exceed the maximum limits set in table 1.4, may be replaced with data collected from additional sample days for the purpose of determining pass or fail. At the manufacturer’s discretion, any data collected on days when the influent UV transmittance is less than 50%, may be replaced with data collected from additional sample days for the purpose of determining pass or fail.
1.5 Effluent criteria

The geometric mean of all required samples of effluent quality shall meet the following criteria:

- fecal coliform ≤ 200 organisms/100 mL; and
- E. coli ≤ 126 organisms/100 mL.

Failure to meet the above criteria shall be a failure to conform to this Standard. Failure to meet the criteria of NSF/ANSI 350 shall be a failure to conform to that Standard if such was requested. Failure under NSF/ANSI 350 does not preclude conformance under this Standard if the above criteria are met. Additional parameters may be collected and analyzed at the request of the manufacturer.

All samples shall be refrigerated according to Standard Methods if not tested within 1 hour of collection.

1.6 Failure sensing and signaling equipment

All disinfection devices with electrical or mechanical components critical to the treatment process shall conform to this section.

The device shall possess a mechanism or process capable of detecting failures of electrical and mechanical components critical to the treatment processes and delivering a visible and audible signal to notify the owner or user of the failure. In some cases, the alarm function is provided by connecting the disinfection device to the control panel of an NSF/ANSI 40, 245 or 350 system.

The visual and auditory signals shall continue to be functional in the event of an electrical, mechanical, or hydraulic malfunction of the disinfection device provided power is available to the system and shall resume all functions once power is restored following the power outage. This requirement does not mandate a battery back-up for the alarm system.
Compliance with the requirements of 1.6.1 and 1.6.2 shall be determined by a group of three observers. Observers shall be employees of the test agency.

1.6.1 Visual alarm testing

The audible portion of the alarm shall be disabled during the visual alarm test. The visual portion of the signal shall be conspicuous from a distance of 15 m (50 ft). There shall be a minimum of five random on/off trials of the visual alarm. The observers shall turn their backs to the alarm panels such that they are unable to see the visual portion of the alarm prior to each trial during the visual alarm test. The visual alarm shall be on for a minimum of one trial and off for a minimum of one trial during the test; the on/off condition shall otherwise be selected randomly. Observers shall face the alarm panel when requested during the test. Compliance with these requirements shall be demonstrated only when all observers provide the correct answer for each trial.

1.6.2 Audible alarm testing

The visual alarm shall be disabled during the audible alarm testing. Observers shall have their backs to the alarm during the audible testing. The audible portion of the signal shall be discernible from a distance of 15 m (50 ft) with a minimum ambient noise level of 60 dbA. When the ambient noise level is less than 60 dbA, it shall be augmented with a steady tone between 100 and 1000 hertz. The ambient noise level shall be measured at the location where the observers shall be located. The audible alarm shall be activated a minimum of three times. The observers shall record the number of times the audible alarm was heard. Compliance with these requirements shall be demonstrated only when all observers record the correct number of times the alarm was activated. The audible portion of the alarm shall not exceed 90 dbA at a distance of 3 m (10 ft) when measured outdoors with both the alarm panel and sound level meter located at a minimum of 7.6 m (25 ft) from any permanent structure.

1.7 Flow design

Disinfection devices shall have a designated flow path that is reflective of the entire treatment process. During periods of normal system operation, as well as periods of disinfection device and component malfunction, the design and construction of the disinfection device shall preclude alternative flow paths and prevent the discharge of untreated wastewater from an opening external to the designated flow path.

The discharge of wastewater from access ports shall be permissible during chlorine disinfection device malfunction. NSF/ANSI 350 devices shall provide for the discharge of untreated water as specified in NSF/ANSI 350.

The manufacturer shall provide the design flow capacity or the range of design flow capacities of the device in terms of the gallons per day the device is designed to treat.

1.8 Analytical methods

Influent challenge water and disinfection device effluent samples shall be analyzed according to Standard Methods. Quality assurance and quality control measures such as EPA QA/QC Protocols for sampling, analysis, and data review shall be incorporated into the overall test, sampling, analytical, and reporting program.
2 Normative references

The following documents contain provisions that, through reference, constitute provisions of this NSF/ANSI Standard. At the time this Standard was balloted, the editions versions (if listed below) were valid. All documents are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the documents indicated below. The most recent published edition of the document shall be used for undated references.

American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF): Standard Methods for the Examination of Water and Wastewater, (hereinafter referred to as Standard Methods)

ANSI/HI. Pump Standards

ASME B40.100 – 2005. Pressure Gauges and Gauge Attachments

NFPA 70®. National Electrical Code® (NEC®)

NSF/ANSI 40. Residential Wastewater Treatment Systems

NSF/ANSI 55. Ultraviolet Microbiological Water Treatment Systems

NSF/ANSI 245. Wastewater Treatment Systems – Nitrogen Reduction

NSF/ANSI 350. Onsite Residential and Commercial Water Reuse Treatment Systems

29 C.F.R. §1910. Occupational Safety and Health Standards

40 C.F.R. §136. Guidelines establishing test procedures for the analysis of pollutants

3 Definitions

ammonia: The non-ionized form of reduced nitrogen (NH3).

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1 Standard Methods for the Examination of Water and Wastewater <www.standardmethods.org>
2 Hydraulic Institute, 9 Sylvan Way, Parsippany, NJ 07054-3802 <www.pumps.org>
3 ASME International, Three Park Avenue, New York, NY 10016-5990 <www.asme.org>
4 National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269 <www.nfpa.org>
5 29 C.F.R. §1910.1000 specifies permissible exposure limits for air contaminants
6 40 C.F.R. §136 specifies which Standard Methods are EPA approved. 40 C.F.R. §136 approval is implied in any reference to Standard Methods.
carbonaceous 5-day biochemical oxygen demand (CBOD<sub>5</sub>): The concentration of oxygen (expressed as mg/L) utilized by microorganisms in the non-nitrogenous oxidation of organic matter during a 5-d period at a temperature of 20 °C (68 °F).

chlorination dispenser: A device that applies chlorine or chlorine compounds to wastewater for the purpose of disinfecting wastewater which has been certified to NSF/ANSI 46.

chlorine disinfection: Disinfection of wastewater by exposure of the biological organisms to an aqueous form of chlorine.

chlorine disinfection device: A chlorine dispenser which delivers chlorine into secondary treated wastewater and utilizes a contact chamber for demonstrating microbiological organism reduction within the treated effluent.

chlorine product reservoir: A component of a chlorine dispenser or chlorine disinfection device used to store chlorine products until they are needed for use.

commercial wastewater treatment system: An organized and coordinated system of components that functions to treat all wastewater generated by a commercial facility.

contact chamber: The tank or compartment that provides mixing and retention time for disinfection to occur.

contaminant: An undesirable organic or inorganic, or soluble or insoluble substance in water. This definition includes microbiological organisms.

corrosion resistant: A material that is capable of maintaining original surface characteristics under prolonged contact with the intended end-use environment and exposure to cleaning or sanitizing procedures according to the manufacturer's recommendations.

disinfection: The killing or inactivation of microbiological organisms by a chemical or physical process.

E. coli (Escherichia coli): The colon bacillus, a bacterium commonly found in warm blooded mammals, that normally resides in the human colon.

electrical component: A part of the disinfection device that provides power, process control, or communications in the disinfection device.

fecal coliform: Bacteria common to the digestive system of warm blooded animals which may be cultured in standard tests.

feed rate: A flow rate from a chemical feed source to the wastewater.

flow capacity: The rated flow for the disinfection device measured in gallons per day (gpd) (Liters per day [Lpd]) as defined by the manufacturer.

flow rate: The flow through a disinfection device measured as gallons per minute (gpm) (Liters per day [Lpd]).
irradiance: The measure of light “intensity” at the surface; the radiant power arriving at a point on a surface, per unit area (mW/cm²).

mechanical component: A part of a disinfection device with an individual and distinct function to perform some type of work in disinfection process that does not contain a power source.

permanently affixed: The method to attach a label as required in this Standard that will at minimum require a tool to remove (e.g., a sticker or plate). Twist Ties and fasteners that are not UV stabilized are excluded from this definition. This excludes twist ties and fasteners that are not UV stabilized.

dozone diffusion device: The mechanism that introduces ozone gas into water to be disinfected.

ozone disinfection device: A device that produces ozone and introduces it into water for the purpose of disinfection and provides sufficient retention time to achieve disinfection.

ozone generator: A device that produces ozone gas.

residential wastewater: Human body waste and liquid waste generated by the occupants of an individual residence.

residential wastewater treatment system: An organized and coordinated system of components that functions to treat all wastewater generated by individual residence(s).

total suspended solids (TSS): The quantity of solids (expressed as mg/L) that is readily removed from a well-mixed sample with standard laboratory filtering procedures.

UV absorbance and transmittance: The fraction of UV light irradiance at 254 nm remaining after passage through a 1.0 cm (0.4 inch) path length of a sample of water measured in percent, that is absorbed or scattered in a solution or is transmitted a standard distance through a solution. UV absorbance and transmittance is expressed as a fraction per cm.

UV disinfection: Disinfection of wastewater by exposure to sufficient intensity and sufficient contact with UV light radiation (254-nm germicidal wavelength light).

UV disinfection device: A device used to irradiate secondary treated wastewater with UV light for sufficient exposure time and with sufficient intensity to reduce microbiological organisms to concentrations meeting this Standard.

UV dose: The product of irradiance at 254 nm and time over a given area expressed as mJ/cm².

UV sensor: A device used to measure UV irradiance.

4 Materials

Materials shall be durable and capable of withstanding stresses and wear during shipping, assembly, installation, and operation. Materials shall not be adversely affected when subjected to the use environment.
NOTE – Because there are numerous design criteria suitable for the manufacture of components and devices used in wastewater treatment systems, manufacturers should acquire appropriate engineering expertise for evaluating the design of such components and devices.

4.1 Dissimilar metals

Dissimilar metal materials, not considered compatible at the electromotive level, shall not be in direct contact. An electrically non-conductive insulating fitting shall be provided at the junction between such dissimilar metal parts or components.

NOTE – ANSI/HI 9.1 - 9.5 provides guidance for protecting against galvanic corrosion. Manufacturers are encouraged to use these guidelines and similar guidelines for the design and construction of wastewater treatment devices and their components.

4.2 Welding

Welded seams and deposited weld materials shall show no visible signs of structural change following performance testing and evaluation, including, but not limited to, flaking, pitting, or the formation of structurally significant cracks.

5 Design and construction

Components and devices shall be fabricated to perform their intended functions when installed and operated according to the manufacturer's instructions. They shall not be adversely affected by the use environment.

5.1 Serviceability

Component parts subject to malfunction or wear shall be accessible for repair or replacement.

5.2 Electrical equipment

Electrical components shall be protected by safety devices, such as circuit breakers and fuses. The NFPA 70® NEC® shall be followed for all electrical components, electrical connections, system installation, and system operation.

5.3 Mechanical components and systems

Mechanical components and systems shall be protected against damage or impairment of efficiency for all normally anticipated operating conditions.

5.4 Data plate

A permanent data plate shall be provided. The plate shall be inscribed and installed so as to be easily seen and understood, and shall be permanently affixed at a location normally visible following recommended installation. It shall include the following:

- name and address (city and state) of manufacturer;
- model and serial number designation; and
6 Chlorine disinfection devices

6.1 Scope

This section establishes the requirements for chlorination devices used to dispense controlled amounts of chlorine into the effluent of secondary treated wastewater for the purpose of disinfecting wastewater. It is intended for devices which deliver chlorine and utilize a chlorine dispenser and a contact chamber for demonstrating microbiological organism reduction within the treated effluent (hereinafter referred to as a chlorine disinfection device). The contact chamber shall be provided by the chlorine disinfection device manufacturer or shall be specified as to minimum size and other criteria if the device is designed to work with other components of a treatment system.

If solid chlorine products are evaluated to the requirements of this Standard, the chlorine disinfection device manufacturer shall specify and provide a chlorine product for the purpose of the evaluation. The results of the evaluation shall be applied to chlorine disinfection devices which have been evaluated to the requirements of this Standard.

6.2 Model series classification

Chlorine disinfection devices within a manufacturer’s model series should be classified according to the performance testing and evaluation of the most representative model within the series. The series shall be comprised of chlorine disinfection devices proportionally similar in design, construction, and materials, and proportionally equivalent in dimensions of the chlorine product reservoir.

Chlorine disinfection devices shall be tested with the smallest contact chamber size specified by the manufacturer. Performance testing and evaluation of larger tank sizes within the series should not be necessary provided that the dimensions, hydraulics, mixing, and other applicable design characteristics are proportionally similar to the evaluated chlorine disinfection device.

6.3 Labels and cleaning

6.3.1 Service label

A clearly visible label or plate that provides instructions for obtaining service shall be permanently affixed in a visible location on the chlorine dispenser, including manufacturer’s or authorized representative’s name, address, and telephone number. The label shall specify the acceptable brand name of solid chlorine or minimum concentration of liquid chlorine to be used in the chlorine disinfection device. The service label shall indicate the required frequency of maintenance for the chlorine disinfection device based on a minimum of one month chlorine supply.

6.3.2 Data plate

The data plate shall specify the device utilizes “chlorine disinfection”.

6.3.3 Ease of cleaning
The chlorine disinfection device shall provide a means for access to any parts that require routine cleaning and maintenance from above ground without excavation or disassembly of major components of the device.

6.3.4 Valve and component identification

All valves and performance indication components shall have a permanently affixed, easily legible, and conspicuous label or tag identifying their operation.

If the chlorine disinfection device is not supplied with plumbing and assorted components including piping, valves, venturi and fittings, the manufacturer shall provide a piping diagram, parts lists, and installation instructions. Closing and sealing devices such as clamps, gaskets, and tightening elements shall be adequate and ensure the operator is protected from hazardous and toxic gases and chemicals (e.g., caustic chemicals, chlorine gas).

6.4 Product literature

Complete installation, operation, and maintenance manuals shall be provided with the chlorine disinfection device. All product literature shall contain applicable caution statements which shall be prominently displayed.

6.4.1 Owner’s manual

Each chlorine disinfection device shall be accompanied by a manufacturer-prepared owner’s manual. The manual shall be provided to the owner at the time of installation. The manual shall be written to be easily understood by the reader and shall include at a minimum:

- the model designation;
- a statement confirming that the chlorine disinfection device meets the applicable requirements of this Standard;
- a functional description of chlorine disinfection device operation, preferably including diagrams illustrating basic design and flow path;
- comprehensive operating instructions that clearly delineate proper function of the chlorine disinfection device, including operating and maintenance responsibilities of the owner and authorized service personnel;
- a statement indicating minimum period of time before cleaning and/or maintenance is required for adequate chlorine disinfection device operation;
- a course of action to be taken if the chlorine disinfection device is to be used intermittently or if an extended period of non-use is anticipated:
- detailed methods and criteria to be used to identify chlorine disinfection device malfunction or problems:
- a statement instructing the owner to refer to the chlorine disinfection device data plate in the event that a problem arises or service is required;
– the name and telephone number of an appropriate service representative to be contacted in the event that a problem with the chlorine disinfection device occurs;
– if applicable, an electrical schematic for the chlorine disinfection device, if none appears on the device;
– all applicable design features necessary for effective dispensing of chlorine, including but not limited to, the type of chlorine to be used, the minimum contact tank size, and the minimum contact time; and

– the acceptable brand name of solid chlorine or minimum concentration of liquid chlorine to be used in the chlorination disinfection device.

### 6.4.2 Installation manual and service providers manual

The chlorine disinfection device manufacturer shall provide (as applicable) a complete piping diagram; wiring diagram, parts list; and installation, operation, and maintenance instructions with the device package.

A service provider’s manual shall be provided with detailed operation and maintenance instructions designed for use by knowledgeable contract service providers. The service manual shall contain all of the information as required for the owner’s manual and shall include:

– comprehensive instructions for startup, inspection, periodic maintenance, operation rebuilding services, and a full parts list;

– checklists of service duties required at specific intervals;

– instructions on how to obtain rapid-response procurement of service items and spare parts;

– instructions on repair or replacement in the event that a system possess flaws flows that inhibit proper functioning, and a list of sources where replacement components are obtainable; and

– for chlorine disinfection devices used on tanks that operate on a pump delivery system for discharge of the chlorinated effluent, the installation manual shall specify the minimum retention time necessary to achieve proper disinfection.

### 6.5 Performance testing and evaluation

Performance testing and evaluation of chlorine disinfection devices shall consist of the following procedures:

1) Chlorine resistance test (see 6.5.1);
2) Life test (see 6.5.2);
3) Microbiological organism deactivation test (see 6.5.3); and
4) Chlorine Loss Test (see 6.5.4)

These tests shall be conducted on one or more chlorination disinfection devices. However, the life test,
microbiological deactivation test, and chlorine loss test shall be conducted on a single dispenser in the order indicated above.

In addition to the testing and evaluation specified in 6.5, components or chlorine disinfection devices that have positive displacement pumps or are designed to operate with increased hydraulic pressure shall be tested and evaluated to the applicable requirements in 6.6 and 6.7, respectively.

6.5.1 Chlorine resistance test

Parts normally in contact with chlorine shall be exposed, as they are in field applications, to the maximum in-use concentration or maximum output for a period of 100 d.

6.5.1.1 Method

1) Fill the chlorine disinfection device to the maximum level with the applicable chemicals as specified by the manufacturer.
   
   a) For solid chlorine disinfection devices, fill the chlorine disinfection device flow path with a potable water supply.

   b) For liquid chlorine disinfection devices, complete one full operational cycle to ensure all components are saturated with chlorine.

2) Seal all inlet and outlet ports with the exception of one port above the flood level to allow any generated gases to escape. Water shall fill the flow path from inlet to outlet when sealed.

3) Expose for a period of 100 d ± 6 h at an ambient room temperature of 20 ± 5 °C (68 ± 10 °F).

6.5.1.2 Criteria

At the conclusion of this test, the components of the chlorine disinfection device shall not show any visible sign of chemical attack or structural deformation. Any observed degradation in the structural or functional integrity of the materials shall be a failure of the test.

6.5.2 Life test

Chlorine dispensers shall be capable of operating for at least 30 d without maintenance. The life test may be completed on the same chlorine disinfection device evaluated for chlorine resistance or on a completely different chlorine disinfection device. However, the life test, microbiological organism deactivation test, and chlorine loss test shall be conducted on a single device in the order indicated above.

− Chlorine dispensers shall be assembled, installed, and operated in accordance with the manufacturer's specifications.

− The manufacturer shall specify all key elements for effective chlorination, including but not limited to, design flow conditions, minimum contact time, minimum contact tank volume. If a chlorine dispenser is submitted for testing without a manufacturer-specified mixing tank or contact chamber, it shall be tested and evaluated by attaching the chlorine dispenser to a default tank (hereinafter referred to as “test contact chamber”). This tank shall be a mixing tank or contact
chamber of the minimum volume and flow path specified by the manufacturer.

- The manufacturer shall specify the maximum and minimum wastewater flow capacity for which the chlorine disinfection device is designed and minimum contact time required between the wastewater and the chlorine disinfectant.

- The manufacturer shall specify the minimum feed rate required for successful treatment when the chlorine dispenser is loaded at the minimum flow capacity and the minimum feed rate required for successful treatment when the chlorine dispenser is loaded at the maximum flow capacity. Testing shall be completed with the minimum feed rate specified for the maximum flow capacity.

- The manufacturer shall specify the type of chlorine to be used with the chlorine disinfection device. In the case of solids, the manufacturer shall specify the manufacturer, brand name, and model or size of the solid. In the case of liquid, the manufacturer shall specify the proper use concentration. The test shall be repeated for alternate solid chlorine products, if varying in formulation and/or size, and alternate liquid chlorine products, if varying in chlorine concentration.

6.5.2.1 Hydraulic loading

Flow conditions shall be as follows (based on the manufacturer’s maximum flow capacity of the chlorine disinfection device):

<table>
<thead>
<tr>
<th>Time</th>
<th>Flow Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 a.m. to 9 a.m.</td>
<td>35% of maximum flow capacity</td>
</tr>
<tr>
<td>11 a.m. to 2 p.m.</td>
<td>25% of maximum flow capacity</td>
</tr>
<tr>
<td>5 p.m. to 8 p.m.</td>
<td>40% of maximum flow capacity</td>
</tr>
</tbody>
</table>

The individual dosage shall be no more than 10 gallons per dose, unless the dosage system is based on a continuous flow, and be uniformly applied over the dosing periods.

Dosing volumes shall be measured daily. The 30-day average volume delivered to the chlorine disinfection device shall be 100% ± 10% of the chlorine disinfection devices rated daily flow capacity.

6.5.2.2 Life test microbiological sampling

Extreme care shall be taken in designing a sampling program and sample site for chlorine disinfected water. The sample point shall be immediately adjacent to the outlet flow of the chlorine disinfection device contact chamber. Sterile samples bottles and sterile sample collection techniques shall be used during sample collection.

Three microbiological organism samples shall be collected and analyzed three times per week over 30 days. Grab samples shall be collected at least 30 min after the start of the loading period. Samples shall be rotated in order of the loading periods per 6.5.2.1 so that one third of the samples shall be collected in each of the loading periods (6.5.2.1). At the three tests per week ratio, each loading period shall have a minimum of five samples (the final week contains only two days but three samples shall be collected during that week).

NOTE - the manufacturer may request additional samples per week complying with the above.

Sample containers shall contain disinfection neutralizer sufficient to halt the disinfecting action. Samples
shall be refrigerated if not analyzed within one hour of collection. Analysis shall be performed within 6 hours of sample collection.

6.5.2.33 Criteria

The geometric mean of microbiological organism concentration from all grab samples collected and analyzed under 6.5.2.2 shall meet the pass/fail criteria in 1.5.

6.5.3 Microbiological organism deactivation test

The microbiological organism deactivation test shall be conducted immediately following the life test using the same chlorine disinfection device that was tested and evaluated during the life test. Maintenance may be performed between the life test and the microbiological organism deactivation test provided it is in accordance with methods and frequency specified in the service provider and owner’s manuals. Chlorine disinfection devices shall be tested at the maximum and minimum flow rate settings based on specified flow capacities as required in 6.5.3.1.1 and 6.5.3.1.2 as appropriate for the chlorine disinfection device being tested.

6.5.3.1 Hydraulic loading

6.5.3.1.1 Variable feed rate devices

The manufacturer shall specify the maximum wastewater flow capacity for both the minimum and maximum chlorine feed rates. Flow shall be introduced continuously or in evenly spaced doses not exceeding 38 L (10 gal) through the treatment system feeding the test chlorine disinfection device. Variable feed rate chlorine disinfection devices shall be tested over 3 dosing periods described in the table below.

<table>
<thead>
<tr>
<th>Hours 0 to 3</th>
<th>Device set to the chlorine feed rate used during the life test with wastewater flow set to the flow rate required to deliver 40% of the maximum flow capacity over the 3-hour period (same as evening dosing during life test).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purge 1</td>
<td>Purge contact chamber for a minimum of 2 chamber volumes with wastewater flow set to the flow rate required to deliver 40% of the minimum flow capacity over the 3-hour period. The device shall be set to deliver minimum chlorine feed specified by the manufacturer for the minimum flow capacity during this purge.</td>
</tr>
<tr>
<td>Hours 3 to 6</td>
<td>Device set to deliver minimum chlorine feed specified by the manufacturer for the minimum flow capacity with wastewater flow rate set to the same rate used in Purge 1.</td>
</tr>
<tr>
<td>Purge 2</td>
<td>Purge contact chamber for a minimum of 2 chamber volumes with wastewater flow set to the flow rate required to deliver 40% maximum flow capacity over the 3-hour period for the maximum feed rate. The device shall be set to deliver the minimum chlorine feed specified by the manufacturer for the maximum flow capacity during this purge.</td>
</tr>
<tr>
<td>Hours 6 to 9</td>
<td>Device set to deliver the same chlorine feed and wastewater flow used in Purge 2.</td>
</tr>
</tbody>
</table>

6.5.3.1.2 Fixed feed rate devices

The manufacturer shall specify the maximum and minimum wastewater flow capacity for the chlorine disinfection device. Flow shall be introduced continuously or in evenly spaced doses not exceeding 38 L (10 gal) through the treatment system feeding the test chlorine disinfection device. Fixed feed chlorine
disinfection devices shall be tested over 3 dosing periods described in the table below.

<table>
<thead>
<tr>
<th>Hours 0 to 3</th>
<th>Wastewater flow set to the rate required to deliver 40% of the maximum flow capacity over the 3-hour period (same as evening dosing during life test).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purge 1</td>
<td>Purge contact chamber for a minimum of 2 chamber volumes with wastewater flow rate set to 10% of the manufacturer's minimum specified flow capacity over the 3 hour period.</td>
</tr>
<tr>
<td>Hours 3 to 6</td>
<td>Wastewater flow set to the same rate used in Purge 1.</td>
</tr>
<tr>
<td>Purge 2</td>
<td>Purge contact chamber for a minimum of 2 chamber volumes with wastewater flow rate set to 40% of the manufacturer's minimum specified flow capacity over the 3 hour period.</td>
</tr>
<tr>
<td>Hours 6 to 9</td>
<td>Wastewater flow set to the same rate used in Purge 2.</td>
</tr>
</tbody>
</table>

If the manufacturer specifies only a single flow capacity, the test shall be completed only at 40% of that daily flow capacity.

Test data may also be collected for additional hydraulic loading tests at the request of the manufacturer based on manufacturer defined flow rates. This data may be included in the final report, but it will not be used as criteria for the performance evaluation.

### 6.5.3.1.3 Microbiological organism deactivation test sampling and analysis

Microbiological grab samples shall be collected 10 minutes, 90 minutes, and 170 minutes into each of the three-hour test periods for both variable feed and fixed feed devices. Sample containers shall contain disinfection neutralizer sufficient to halt the disinfecting action. Samples shall be refrigerated if not analyzed within one hour of collection. Analysis shall be performed within 6 hours of sample collection.

### 6.5.3.1.4 Criteria

At the conclusion of the test, there shall be no visible signs of damage or structural change that adversely affect proper operation of any components of the chlorine disinfection device. The evaluation shall be performed following completion of the microbiological organism deactivation test, as specified in 6.5.3.

The geometric mean of microorganisms from all grab samples collected and analyzed under 6.5.3.1.3 shall meet the pass/fail criteria in 1.5.

### 6.5.4 Chlorine loss test

The test setup shall simulate a chlorine disinfection device installed between a treatment plant and a pump vault in accordance with the manufacturer's installation instructions. A chlorine gas detector shall be installed near the inlet to the chlorine disinfection device to detect chlorine gas feeding back into the treatment unit. A second chlorine gas detector shall be installed near the discharge of the contact chamber to monitor chlorine gas discharge through the outlet of the contact chamber. The detectors shall be mounted above and within 0.3 m (1 ft) in all directions of the invert of the pipe. In the event of multiple inlets or outlets, all inlets and outlets shall be monitored for chlorine loss. Readings from the detectors shall be measured and recorded at three intervals evenly spaced throughout the life test (1st, 15th, and 30th day of testing).
The chlorine loss test shall be conducted simultaneously with the chlorine device life test and microbiological organism deactivation test. All data collected during this test shall be included in the final report and it will not be used as criteria for the performance evaluation.

6.5.5 Upset test conditions

In the event that conditions during the testing and evaluations period result in system upset, improper sampling, improper dosing, or influent characteristics outside the ranges specified in 1.4, an assessment shall be conducted to determine the extent to which these conditions adversely affected the performance of the system. Based on this assessment, specific data points should be excluded from the geometric means of chlorine disinfection measurements. Rationale for all data exclusions shall be documented in the final report.

In the event that a catastrophic site problem not described in this Standard, including, but not limited to, influent characteristics, malfunctions of test apparatus, and acts of nature, jeopardizes the validity of the performance testing and evaluation, manufacturers shall be given the choice to:

− perform maintenance of the system, reinitiate system start-up procedures, and restart the performance testing and evaluation; or

− with no routine maintenance performed, have the system brought back to pre-existing conditions and resume testing within three weeks after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from the geometric means of chlorine disinfection performance.

6.6 Performance testing and evaluation for positive displacement pumps

6.6.1 Suction lift

Chlorine disinfection devices incorporating a positive displacement pump operating with a suction lift of 1.2 m (4 ft) of water, at 80% back pressure and 100% of their rated capacity, shall deliver an output rate that is within ± 10% of the delivery specified by the manufacturer.

6.6.2 Apparatus

− 19 L (5 gal) container;
− Stopwatch accurate to ± 0.1 s;
− Injection manifold with pressure tap and throttling valve;
− Pressure gauge meeting ASME B40.100 Grade 3A³ specifications sized to yield the measurement within 25% to 75% of scale;
− Measuring device accurate to 1.6 mm (1/16 in);
− Recirculation tank with a pump capable of delivering sufficient back pressure; and
− Scale accurate to ± 0.005 kg (± 0.01 lb).
6.6.3 Water temperature

The water used to test suction lift of chlorine disinfection devices shall be room temperature.

6.6.4 Method

1) Assemble the chlorine disinfection device in accordance with the manufacturer’s instructions and set the delivery to 100% of its capacity.

2) Attach the chlorine disinfection device discharge line to the injection manifold.

3) Fill the 19 L (5 gal) container with water conditioned to the temperature specified in 6.6.3. Place the container on the scale and position the chlorine disinfection device 1.2 m (4 ft) above the water level in the container.

4) Fully prime the chlorine disinfection device according to the manufacturer’s instructions.

5) Start the recirculation pump and adjust the back pressure to 80% of the maximum pressure specified on the manufacturer’s delivery output data plate.

6) Note the weight \( W_1 \) on the scale upon starting the stopwatch. Allow the chlorine disinfection device to operate for 1 ± 0.1 h. Note the weight \( W_2 \) on the scale upon stopping the stopwatch, and record the duration of the test (time). Determine the density of the water at the test temperature (D).

7) Calculate the delivery in units of volume per unit of time as follows:

\[
\text{Delivery} = \frac{(W_1 - W_2)}{D} / \text{time}
\]

6.6.5 Criteria

The chlorine disinfection device having a positive displacement pump shall deliver an output rate that is within ± 10% of the delivery specified by the manufacturer.

6.7 Performance testing and evaluation for pressurized components

This section applies to chlorine disinfection devices intended to operate under increased hydraulic pressure.

6.7.1 Purpose

The purpose of this section’s requirements is to verify that a chlorine disinfection device and its components can withstand hydrostatic pressure 1 ½ times the manufacturer’s maximum operating pressure.

6.7.2 Apparatus

- Pressure gauge meeting ASME B40.100 Grade 3A3 specifications sized to yield the measurement of 25% to 75% of scale;

- Hydrostatic pressure station; and
6.7.3 Water temperature

The water used to perform hydrostatic pressure testing of chlorine disinfection devices shall be room temperature.

6.7.4 Method

1) Install the chlorine disinfection device in accordance with the manufacturer’s instructions.

2) Fill the chlorine disinfection device with water conditioned to the applicable temperature specified in 6.6.3, and bleed off all entrapped air.

3) Uniformly increase the pressure to obtain 1 ½ times the maximum rated working pressure, and hold the pressure for no less than 5 minutes. Examine the chlorine disinfection device and components for signs of leakage during the test period.

4) Slowly release the pressure and examine the unit.

6.7.5 Criteria

Chlorine disinfection devices intended for pressure applications shall show no evidence of rupture, leakage, burst, or permanent deformation when subjected to a hydrostatic pressure 1½ times the manufacturer’s maximum operating pressure.

6.8 Final report

A final report shall be prepared that presents all data collected and observations made in accordance with the performance testing and evaluation specified in section 6. It shall include all significant findings, including the following:

- descriptions and timing of all problems and observations;
- hydraulic loading volumes delivered throughout the test;
- analytical data for all influent and effluent sample points; and
- a statement of compliance or non-compliance with the requirements of this Standard.

7 Ultraviolet (UV) disinfection devices

7.1 Scope

This section establishes requirements for UV devices used to irradiate and disinfect secondary treated wastewater. It is intended for devices that deliver UV light radiation to secondary treated wastewater from small sources such as individual homes or similar capacity commercial sources and provide exposure chamber for microbiological organisms reduction (hereinafter referred to as UV disinfection devices).

7.2 Model series classification
UV disinfection devices within a manufacturer’s model series shall be classified according to the performance testing and evaluation of the most representative model within the series. Contact time, mixing, turbulence, light path length, and other critical design criteria shall be shown to be representative for the series. The series shall be comprised of UV disinfection devices proportionally similar in design, construction and materials, and shown to have equivalent UV exposure characteristics.

7.3 Flow delivery

Systems shall be classified as gravity flow or pumped delivery. The same system shall carry both classifications if proven to meet the respective criteria of this Standard for each delivery method.

7.4 Design and construction

UV disinfection devices shall be constructed to be resistant to UV and to function as directed by the manufacturer.

7.4.1 Service label

A clearly visible label or plate that provides instructions for obtaining service shall be permanently affixed in a visible location on the UV disinfection device, including the manufacturer’s or authorized representative’s name, address and telephone number. The service label shall indicate the required frequency of maintenance for the UV disinfection device.

7.4.2 Data plate

The data plate shall specify the device utilizes “UV disinfection”.

7.4.3 Ease of cleaning

The UV disinfection device shall provide a means for access to any parts that require routine cleaning and maintenance from above ground without excavation or disassembly of major components of the device.

7.4.4 Lamp replacement

The recommended lamp replacement intervals shall be verified by submittal of irradiance versus time curves as supplied by the lamp manufacturer. The irradiance shall be measured at 254 nm at a distance of 1.0 m (3.3 ft) from the lamp. Lamp replacement shall be recommended to occur prior to the time 70% of the initial irradiance is reached. Lamps shall be replaced with lamps specified in the UV disinfection device owner’s manual.

7.4.5 Component and system safety

Closing and sealing devices such as clamps, gaskets, and tightening elements shall be adequate to limit opportunity for exposure of the operator, owner, and people near the device to the UV light. Proper labeling shall warn of the danger of UV light exposure. Access ports shall be protected against UV light exposure. Acceptable protective measures include, but not limited to, a locking device, an interlock switch that automatically disables the UV source or a cover that is removable only with specialized tools.

7.5 Product literature
Complete installation, operation, and maintenance manuals shall be provided with the UV disinfection device. All product literature shall contain applicable caution statements which shall be prominently displayed.

7.5.1 Owner’s manual

Each UV disinfection device shall be accompanied by a manufacturer-prepared owner’s manual. The manual shall be provided to the owner at the time of installation. The manual shall be written to be easily understood by the reader and shall include at a minimum:

- a model designation;
- a statement confirming that the UV disinfection device meets the applicable requirements of this Standard;
- a functional description of UV disinfection device operation, including diagrams illustrating basic design and flow-path;
- comprehensive operating instructions that clearly delineate proper function of the UV disinfection device, including operating and maintenance responsibilities of the owner and authorized service personnel;
- a statement indicating the minimum period of time before cleaning or maintenance or both is required for adequate UV disinfection device operation;
- a course of action to be taken if the UV disinfection device is to be used intermittently or if extended periods of non-use are anticipated;
- detailed methods and criteria to be used to identify UV disinfection device malfunction or problems;
- a statement instructing the owner to refer to the UV disinfection device service label in the event that a problem arises or service is required;
- a statement instructing the owner to have the system inspected in the event of an upset in the upstream biological secondary treatment unit;
- instructions on lamp replacement including the manufacturer and model number of the lamp and other scheduled or normally anticipated operation and maintenance functions;
- the name and telephone number of an appropriate service representative to be contacted in the event that a problem with the UV disinfection device occurs;
- an electrical schematic for the UV disinfection device, if none appears on the device; and
- descriptions of all applicable design features that are necessary for effective disinfection, including but not limited to, the type of UV lamp to be used and minimum exposure time related to flow.
7.5.2 Installation manual and service providers manual

The UV disinfection device manufacturer shall provide a complete piping diagram; wiring diagram, parts list; and installation, operation, and maintenance instructions with the device package.

A service provider’s manual shall be provided with detailed operation and maintenance instructions designed for use by knowledgeable contract service providers. The service manual shall contain all of the information as required in the owner’s manual and shall include:

- comprehensive instructions for startup, inspection, periodic maintenance, operation rebuilding services, and a full parts list;
- checklists of service duties required at specific intervals;
- instructions on how to obtain rapid-response procurement of service items and spare parts; and
- instructions on repair or replacement in the event that a system possess flaws that inhibit proper functioning, and a list of sources where replacement components are obtainable.

7.6 Performance testing and evaluation

The following testing shall be conducted on one UV disinfection device. In testing a model in order to gain test data to be used for approval of a model series, the most representative model within the series shall be tested. In addition to the testing and evaluation specified in 7.6, components and devices that are designed to operate with increased hydraulic pressure shall be tested and evaluated to the applicable requirements in 7.7.

UV disinfection devices shall be capable of operating for at least 180 d with no operation or maintenance performed on the UV disinfection device.

7.6.1 Life test

UV disinfection devices shall be assembled, installed, and operated in accordance with the manufacturer’s specifications.

Manufacturers shall specify all key elements for effective UV disinfection, including but not limited to, design flow conditions, minimum contact time, and mixing requirements.

The UV disinfection device manufacturer shall specify the maximum and minimum gpm wastewater flow rates that the device including the integral contact chamber is designed to handle. If the UV disinfection device is capable of receiving influent both as pump-delivered flow and gravity-delivered flow, the manufacturer shall specify the minimum and maximum gpm wastewater flow rates for each delivery method. If there is a negative impact on the performance of the device from a zero flow condition, the manufacturer shall provide the minimum acceptable flow rate; otherwise the minimum flow rate shall be no flow. The manufacturer shall specify the minimum and maximum design flow capacity of the device for both pumped and gravity fed systems, if applicable.
The UV disinfection device shall be operated in accordance with the manufacturer’s instructions. However, routine service and maintenance of the system shall not be permitted during the performance testing and evaluation period.

The UV disinfection device manufacturer shall specify the UV lamp to be used with the device. Lamp specifications shall include, at a minimum, lamp length; rated UV output (watts at 254 nm); irradiance at 1 m (3 ft); and irradiance versus time with corresponding rated lamp life, defined as the point where irradiance is reduced to 70% of initial performance.

There shall be 100 hour burn-in of the UV lamp before testing according to the manufacturer’s specifications.

7.6.1.1 Flow capacity range

UV disinfection devices with two or more design flow capacities shall be tested at the minimum and maximum flow capacity, taking into consideration claims of the manufacturer for use of the device on both pump-delivered and gravity-delivered influent flow. The device shall be tested as shown below at the manufacturer’s maximum and minimum flow capacity:

<table>
<thead>
<tr>
<th>Week 1 – 13 of Testing</th>
<th>maximum flow capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 14 – 26 of Testing</td>
<td>minimum flow capacity</td>
</tr>
</tbody>
</table>

7.6.1.2 Hydraulic loading

Dosing shall be as follows based on manufacturer’s rated flow capacity in the mode being tested, pressure feed or gravity:

<table>
<thead>
<tr>
<th>Time</th>
<th>Flow Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 a.m. to 9 a.m.</td>
<td>35% rated flow capacity</td>
</tr>
<tr>
<td>11 a.m. to 2 p.m.</td>
<td>25% rated flow capacity</td>
</tr>
<tr>
<td>5 p.m. to 8 p.m.</td>
<td>40% rated flow capacity</td>
</tr>
</tbody>
</table>

The individual dosage shall be no more than 10 gallons per dose, unless the dosage system is based on a continuous flow, and be uniformly applied over the dosing periods.

Dosing volumes shall be measured daily. The 30-d average volume of the wastewater delivered to the system shall be within 100% ± 10% of the UV disinfection device’s rated flow capacity.

Instantaneous flow rate data shall be measured and recorded at three intervals evenly spaced throughout the life test during each of the dosing periods at both ends of the flow capacity range for a minimum of nine data points for single capacity or 18 data points for ranged capacity UV disinfection devices. All instantaneous flow rate data collected shall be noted in the final report.

7.6.1.3 Microbiological organism deactivation test

Extreme care shall be taken in designing a sampling program and sample site for UV disinfected water. Since no residual remains when the sample is removed from the UV light exposure, re-growth of organisms and contamination of samples in a testing environment is possible. The sample point shall be immediately adjacent to the outlet flow of the UV disinfection device. Sterile sample bottles and sterile sample collection techniques shall be used during sample collection.
Microbiological organism values shall be collected twice per week where one grab sample is collected beginning 30 min after the start of the hydraulic loading period. Samples shall be rotated in order of the hydraulic loading periods per 7.6.1.2 so that one third of the samples shall be in each of the hydraulic loading periods (7.6.1.2). At the two tests per week ratio, each hydraulic loading period shall have a minimum of 17 samples.

NOTE - the manufacturer may request additional samples per week complying with the above.

Samples shall be refrigerated if not analyzed within one hour of collection. Analysis shall be performed within 6 hours of sample collection.

7.6.2 Criteria

The geometric mean of microbiological organism concentration from all grab samples collected during the first 13 weeks of the life test shall meet the pass/fail criteria in 1.5. The geometric mean of microbiological organism concentration from all grab samples collected in the final 13 weeks of the life test shall meet the pass/fail criteria in 1.5.

7.6.3 Components

All components of the UV disinfection device that are designed to be exposed to wastewater and UV light shall be resistant to UV attack, corrosion, and structural deformation. The UV disinfection device shall be examined for any sign of degradation in the materials at the end of the UV disinfection test. Any observed degradation in the structural or functional integrity of the materials shall be a failure of the test.

7.6.4 Upset test conditions

In the event that conditions during the testing and evaluations period result in system upset, improper sampling, improper dosing, or influent characteristics outside the ranges specified in 1.4, an assessment shall be conducted to determine the extent to which these conditions adversely affected the performance of the system. Based on this assessment, specific data points should be excluded from the averages of UV disinfection measurements. Rationale for all data exclusions shall be documented in the final report.

In the event that a catastrophic site problem not described in this Standard including, but not limited to, influent characteristics, malfunctions of test apparatus, and acts of nature, jeopardizes the validity of the performance testing and evaluation, manufacturers shall be given the choice to:

- perform maintenance of the system, reinitiate system startup procedures, and restart the performance testing and evaluation; or

- with no routine maintenance performed, have the system brought back to pre-existing conditions and resume testing within three weeks after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from averages of UV disinfection device performance.

7.7 Performance testing and evaluation for pressurized components

This section applies to UV disinfection devices intended to operate under increased hydraulic pressure.

7.7.1 Purpose
This section applies to UV disinfection devices designed as pressure systems. The purpose of its requirements is to verify that a pressure-rated UV disinfection device and its components shall withstand hydrostatic pressure 1 ½ times the manufacturer’s maximum designated operating pressure.

7.7.2 Apparatus
- pressure gauge meeting ASME B40.100 Grade 3A3 specifications sized to yield the measurement of 25% to 75% of scale;
- hydrostatic pressure station; and
- thermometer accurate to ± 0.5 °C (± 1 °F).

7.7.3 Water temperature
The temperature of the water used to perform hydrostatic pressure testing of UV disinfection devices shall be 18 ± 6 °C (60 ± 20 °F).

7.7.4 Method
Install the UV disinfection device in accordance with the manufacturer’s instructions. Fill the UV disinfection device with water conditioned to the applicable temperature specified in 7.7.3, and bleed off all entrapped air.

Uniformly increase the pressure to obtain 1 ½ times the maximum rated working pressure, and hold the pressure for no less than 5 minutes. Examine the UV disinfection device and components for signs of leakage during the test period. Slowly release the pressure and disassemble and examine the UV disinfection device for signs of any damage or deformation.

7.7.5 Criteria
UV disinfection devices intended for pressure applications shall show no evidence of rupture, leakage, burst, or permanent deformation when subjected to a hydrostatic pressure 1 ½ times the manufacturer’s maximum operating pressure.

7.8 Final report
A final report shall be prepared that presents all data collected and observations made in accordance with the performance testing and evaluation specified in section 7. It shall include all significant findings, including the following:
- descriptions and timing of all problems and observations;
- hydraulic loading volumes delivered throughout the test;
- analytical data for all influent and effluent sample points; and
- a statement of compliance or non-compliance with the requirements of this Standard.

8 Ozone disinfection devices
8.1 Scope

This section establishes the requirements for ozone disinfection devices used to diffuse controlled amounts of ozone into the effluent of secondary treated wastewater for the purposes of disinfecting wastewater. It is intended for devices that deliver ozone into a contact chamber for demonstrating microbiological organism reduction (hereafter referred to as an ozone disinfection device).

8.2 Model series classification

Ozone disinfection devices within a manufacturer’s model series should be classified according to the performance testing and evaluation of the most representative model within the series. The series shall be comprised of ozone disinfection devices proportionally similar in design, construction, and materials, and proportionally equivalent in dimension, to the rate of ozone generation.

Ozone disinfection devices shall be tested with the contact chamber size which provides the greatest challenge in meeting the performance criteria in this Standard. The manufacturer shall present reasonable documentation describing why the chosen size is the most challenging. The manufacturer shall provide specifications regarding minimum and maximum acceptable water levels to be maintained in the contact chamber in addition to any important ratios which are to be maintained during operation such as diameter-to-depth ratios, perimeter-to-depth, or volume-to-depth. Performance testing and evaluation of other model sizes within the series are not necessary, provided that the dimensions, hydraulics, mixing, and other applicable design characteristics are proportionally similar to the evaluated system.

8.3 Design and construction

All ozone disinfection devices shall comply with the requirements of 8.3 through 8.5.

8.3.1 Noise

When installed according to the manufacturer’s instructions, the ozone disinfection device shall not produce excessive noise. Noise associated with operation, measured at 1.2 m (4 ft) above the ground surface, 6 m (20 ft) in four directions at 90, 180, 270 and 360 degrees from the ozone disinfection device and its appurtenances shall not exceed 60 dbA.

8.3.3 Service label

A clearly visible label or plate that provides instructions for obtaining service shall be permanently affixed in a visible location on the ozone disinfection device, including the manufacturer’s or authorized representative’s name, address, and telephone number. The label shall specify the minimum and maximum size(s) of contact tank(s) to be used with the ozone disinfection device. The service label shall indicate the required frequency of maintenance for the ozone disinfection device.

8.3.4 Data plate

The data plate shall specify the device utilizes “Ozone Disinfection”.

8.3.5 Ease of cleaning
The ozone disinfection device shall provide a means for access to any parts that require routine cleaning and maintenance from above ground without excavation or disassembly of major components of the device.

### 8.4 Valve and component identification

All valves and performance indication components shall have a permanent, easily legible, and conspicuous label or tag identifying their operation. Ozone disinfection devices should be installed in several spatial configurations to fit the available space. If the ozone disinfection device is not supplied with plumbing and assorted components including piping, valves, venturi and fittings, etc., to complete the particular spatial arrangement, the manufacturer shall also supply information on the maximum lengths of any piping components. Closing and sealing devices such as clamps, gaskets, and tightening elements shall be adequate and ensure the operator is protected from hazardous and toxic gases and chemicals (e.g., caustic chemicals, harmful levels of ozone gas).

### 8.5 Product literature

All product literature shall contain applicable caution statements and be prominently displayed.

#### 8.5.1 Owner's manual

Each ozone disinfection device shall be accompanied by a manufacturer-prepared owner’s manual. The manual shall be provided to the owner at the time of installation. The manual shall be written to be easily understood by the reader and shall include, at a minimum:

- the model designation;
- a statement confirming that the ozone disinfection device meets the applicable requirements of this Standard;
- a functional description of ozone disinfection device operation, preferably including diagrams illustrating basic design and flow path;
- comprehensive operating instructions that clearly delineate proper function of the ozone disinfection device including operating and maintenance responsibilities of the owner and authorized service personnel;
- a statement indicating the minimum period of time before cleaning or maintenance or both is required for adequate ozone disinfection device operation;
- a course of action to be taken if the ozone disinfection device is to be used intermittently or if extended periods of non-use are anticipated;
- detailed methods and criteria to be used to identify ozone disinfection device malfunction or problems;
- a statement instructing the owner to refer to the ozone disinfection devices data plate in the event that a problem arises or service is required;
− the name and telephone number of an appropriate service representative to be contacted in the event that a problem with the ozone disinfection device occurs;

− a schematic for the ozone disinfection device, if none appears on the device;

− all applicable design features that are necessary for effective dispensing of ozone, including, but not limited to, the required rate of ozone generation, the minimum and maximum contact tank size, and the minimum contact time;

− instructions on ozone generator replacement including the manufacturer and model number of the ozone generator and other scheduled or normally anticipated operation and maintenance functions; and

− a statement indicating the safety concerns related to ozone gas and any applicable cautions and warnings.

8.5.2 Installation manual

The ozone disinfection device manufacturer shall provide (as applicable) a complete piping diagram; wiring diagram, parts list; and installation, operation, and maintenance instructions with the device package.

A service provider’s manual shall be provided with detailed operation and maintenance instructions designed for use by knowledgeable contract service providers. The service manual shall contain all of the information as required for the owner’s manual and shall include:

− comprehensive instructions for startup, inspection, periodic maintenance, operation rebuilding services, and a full parts list;

− checklists of service duties required at specific intervals;

− instructions on how often to obtain rapid-response procurement of service items and spare parts; and

− instructions on repair or replacement in the event that a system possess flaws that inhibit proper functioning, and a list of sources where replacement components are obtainable.

8.6 Performance testing and evaluation

Performance testing and evaluation of ozone disinfection devices shall consist of the following procedures:

1) Life test (see 8.6.1);

2) Microbiological organism deactivation test (see 8.6.1.2); and

3) Ozone loss test (see 8.6.3).

These tests shall be conducted on one ozone disinfection device.

8.6.1 Life test
Ozone disinfection device shall be capable of operating for 180 consecutive days. During the life test, no maintenance shall be performed on the ozone disinfection device. Ozone disinfection devices shall be assembled, installed, and operated in accordance with the manufacturer’s specifications.

The manufacturer shall specify all key elements for effective ozonation, including, but not limited to, ozone generation rate (measured at beginning and end of testing), ozone diffusion and dispersion criteria, minimum and maximum contact chamber sizing including minimum and maximum acceptable water levels and applicable diameter to depth ratios, design flow conditions, minimum contact time, and mixing requirements.

If an ozone disinfection device is submitted for testing without a manufacturer specified contact chamber, it shall be tested and evaluated by attaching the device to a default tank. This tank shall be a contact chamber designed to allow for the minimum contact time specified by the manufacturer.

The manufacturer shall specify the maximum and minimum wastewater flow capacities for which the device is designed and minimum dwell time required for the wastewater in the contact chamber.

**8.6.1.1 Hydraulic loading**

Flow conditions for the life test shall be as follows based on the manufacturer’s maximum rated flow capacity of the ozone disinfection device:

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Percentage of Flow Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 a.m. to 9 a.m.</td>
<td>35% of maximum flow capacity</td>
</tr>
<tr>
<td>11 a.m. to 2 p.m.</td>
<td>25% of maximum flow capacity</td>
</tr>
<tr>
<td>5 p.m. to 8 p.m.</td>
<td>40% of maximum flow capacity</td>
</tr>
</tbody>
</table>

The individual dosage shall be no more than 10 gallons per dose, unless the dosage system is based on a continuous flow, and be uniformly applied over the dosing periods.

Dosing volumes shall be measured daily. The 30-day average volume delivered to the ozone disinfection device shall be 100% ± 10% of the ozone disinfection devices rated daily flow capacity.

The ozone feed shall be set to the minimum rate specified by the manufacturer for treating the maximum flow capacity.

**8.6.1.2 Microbiological organism deactivation test**

Extreme care shall be taken in designing a sampling program and sample site for ozone disinfected water. Since no residual remains when the sample is removed from the ozone exposure, re-growth of or organisms and contamination of samples in a testing environment is possible. The sample point shall be immediately adjacent to the outlet flow of the ozone disinfection device contact chamber. Sterile sample bottles and sterile sample collection techniques shall be used during sample collection.

Two microbiological organism samples shall be collected and analyzed per week over 26 weeks. Grab samples shall be collected at least 30 min after the start of the loading period. Samples shall be rotated in order of the loading periods per 8.6.1.1 so that one third of the samples shall be collected in each of the loading periods (8.6.1.1). At the two tests per week ratio, each loading period shall have a minimum of 17 samples.

**NOTE** - the manufacturer may request additional samples per week complying with the above.
Samples shall be refrigerated if not analyzed within one hour of collection. Analysis shall be performed within 6 hours of sample collection.

8.6.1.3 Criteria

The geometric mean of microbiological organism concentration from all grab samples collected and analyzed under 8.6.1.2 shall meet the pass/fail criteria in 1.5.

8.6.2 Ozone loss evaluation

The test setup shall simulate an ozone disinfection device installed between a treatment plant and a pump vault in accordance with the manufacturer’s installation instructions. An ozone detector shall be installed near the inlet to the ozone disinfection device to detect ozone gas feeding back into the treatment unit. A second ozone detector shall be installed near the discharge of the contact chamber to monitor ozone discharge through the outlet of the contact chamber. The detectors shall be mounted above and within 0.3 m (1 ft) in all directions of the invert of the pipe. In the event of multiple inlets or outlets, all inlets and outlets shall be monitored for ozone loss. Readings from the detectors shall be measured and recorded on three separate days evenly spaced throughout the life test (one day during the 1st, 14th, and 26th week of testing).

The ozone loss evaluation shall be conducted simultaneously with the Ozone disinfection test and Microbiological organism deactivation test. All data collected during this test shall be included in the final report and # will not be used as criteria for the performance evaluation.

8.6.3 Components

All components of the ozone disinfection device that are designed to be exposed to wastewater and ozone shall be resistant to ozone attack, corrosion, and structural deformation. The ozone disinfection device shall be examined for any sign of degradation in the materials at the end of the ozone disinfection test. Any observed degradation in the structural or functional integrity of the materials shall be a failure of the test.

8.6.4 Upset test conditions

In the event that conditions during the testing and evaluations period result in system upset, improper sampling, improper dosing, or influent characteristics outside the ranges specified in 1.4, an assessment shall be conducted to determine the extent to which these conditions adversely affected the performance of the system. Based on this assessment, specific data points should be excluded from the averages of ozone disinfection measurements. Rationale for all data exclusions shall be documented in the final report.

In the event that a catastrophic site problem not described in this Standard including, but not limited to, influent characteristics, malfunctions of test apparatus, and acts of nature, jeopardizes the validity of the performance testing and evaluation, manufacturers shall be given the choice to:

- perform maintenance of the system, reinitiate system startup procedures, and restart the performance testing and evaluation; or
− with no routine maintenance performed, have the system brought back to pre-existing conditions and resume testing within three weeks after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from averages of ozonation disinfection device performance.

8.7 Final report

A final report shall be prepared that presents all data collected and observations made in accordance with the performance testing and evaluation specified in section 8. It shall include all significant findings, including the following:

− descriptions and timing of all problems and observations;
− hydraulic loading volumes delivered throughout the test;
− analytical data for all influent and effluent sample points; and
− a statement of compliance or non-compliance with the requirements of this Standard.
Annex A
(informational)⁷

A.1 Timeline for Testing

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TEST</th>
<th>FREQUENCY</th>
<th>TOTAL TESTS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5.1</td>
<td>Chlorine Resistance</td>
<td>1</td>
<td>1</td>
<td>100 day test</td>
</tr>
<tr>
<td>6.5.2</td>
<td>Life Test</td>
<td>1</td>
<td>15</td>
<td>30 day, Bacteria tests specified</td>
</tr>
<tr>
<td>6.5.3</td>
<td>Deactivation test</td>
<td>3</td>
<td>9</td>
<td>9 hours checking bacteria kill at both ends of specified flow capacity</td>
</tr>
<tr>
<td>6.5.4</td>
<td>Cl loss</td>
<td>1</td>
<td>1</td>
<td>Concurrent with life test</td>
</tr>
<tr>
<td>7.6.1.3</td>
<td>Deactivation Test</td>
<td>2/week</td>
<td>51 min</td>
<td>Tests rotate with loading periods, 13 weeks analyzed at each flow capacity</td>
</tr>
<tr>
<td>7.6.3</td>
<td>Components</td>
<td>1</td>
<td>1</td>
<td>Visual examination of components</td>
</tr>
<tr>
<td>8.6.1.2</td>
<td>Deactivation Test</td>
<td>2/week</td>
<td>51 min</td>
<td>180 day with bact. tests</td>
</tr>
<tr>
<td>8.6.2</td>
<td>ozone loss</td>
<td>1</td>
<td>1</td>
<td>concurrent with life test</td>
</tr>
<tr>
<td>8.6.3</td>
<td>Components</td>
<td>1</td>
<td>1</td>
<td>Visual examination of components</td>
</tr>
</tbody>
</table>

A.2 Matrices for collection of samples

<table>
<thead>
<tr>
<th>Chlorine (24 total samples collected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine resistance test</td>
</tr>
<tr>
<td>duration</td>
</tr>
<tr>
<td># samples</td>
</tr>
<tr>
<td>maintenance</td>
</tr>
<tr>
<td>section</td>
</tr>
</tbody>
</table>

⁷ The information contained in this Annex is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI’s requirements for an ANS. As such, this Annex may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.
UV (51 total samples collected)

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<tr>
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<th>Microbiological organism deactivation test</th>
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<tbody>
<tr>
<td>duration</td>
<td>180 d</td>
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<tr>
<td># samples</td>
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<tr>
<td>maintenance</td>
<td>No</td>
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Ozone (51 total samples collected)

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