

# 2018 Model Aquatic Health Code

## *Code Language*

### Mini-MAHC: Reducing the Spread of *Cryptosporidium*



U.S. Department of  
Health and Human Services  
Centers for Disease  
Control and Prevention

Extracted from the 2018 MAHC

CS295591-A

# Mini-MAHC

## Reducing the Spread of *Cryptosporidium*

CDC's Model Aquatic Health Code (MAHC) consists of two guidance documents:

1. Code Language (3<sup>rd</sup> Edition, 2018)
2. Annex/ Rationale (3<sup>rd</sup> Edition, 2018)

### **Purpose:**

Specific public health issues addressed in the MAHC are often spread across multiple chapters. Mini-MAHCs are intended to make the MAHC more accessible by summarizing the code and annex language into a single, concise document. This will help environmental health practitioners and pool operators quickly find relevant MAHC guidelines and rationale so they can use the information to promote patron and staff health and safety.

This Mini-MAHC Code focuses on reducing the spread of *Cryptosporidium* (Crypto). The language presented will help decrease the public health impact of contamination through: inactivation of oocysts by secondary U.V. or ozone disinfection systems, inspections of systems, and remediation after diarrheal fecal incidents to prevent the spread of Crypto associated with swallowing contaminated water. It references content from the 2018 MAHC Code Language (3<sup>rd</sup> Edition).

### About *Cryptosporidium*

- *Cryptosporidium* is a microscopic germ—a parasite that causes cryptosporidiosis or prolonged, watery diarrhea.
- Crypto can be found in water, food, soil or on surfaces or hands that have been contaminated by the feces of humans or animals infected with the parasite.
- Crypto is very chlorine tolerant and can survive for days, even in well-maintained pools and splash pads.
- Once the water is contaminated by a diarrheal fecal release, all it takes is for someone to swallow a small amount of water to become ill.
- Crypto is the leading cause of outbreaks linked to treated aquatic venues in the United States.
- The parasite is found in every region of the United States and throughout the world.

### **IMPORTANT**

Unless otherwise noted,

- Provisions in Chapter 4 (Aquatic Facility Design Standards and Construction) apply only to new construction or substantial alteration to an existing aquatic facility or venue.
- Provisions in Chapter 5 (Operation & Maintenance) apply to all aquatic facilities covered by the MAHC regardless of when constructed.
- Provisions in Chapter 6 (Policies & Management) apply to all aquatic facilities covered by the MAHC regardless of when constructed.

We removed citations to condense the Mini-MAHCs. A list of references are in the complete version of the 2018 MAHC Annex (3<sup>rd</sup> Edition).

<sup>A</sup> = denotes where information is further supplemented in the MAHC Annex (Rationale).

## 1.0 Preface

### 1.2 Recreational Water-Associated Illness Outbreaks and Injuries

**1.2.1<sup>A</sup> RWI Outbreaks** Large numbers of recreational water-related outbreaks are documented annually, which is a significant increase over the past several decades.

**1.2.2<sup>A</sup> Significance of *Cryptosporidium*** *Cryptosporidium* causes a diarrheal disease spread from one person to another or, at AQUATIC VENUES, by ingestion of fecal-contaminated water. This pathogen is tolerant of CHLORINE and other halogen disinfectants.

## 3.0 Glossary of Acronyms, Initialisms, and Terms Used in the MAHC Code

### 3.2 Glossary of Terms Used in the MAHC Code

*Note: Defined glossary words and terms are in "SMALL CAPS" in the text of the code and annex chapters to alert the reader that there is a specific meaning assigned to those terms and that the meaning of a provision is to be interpreted in the defined context. Only Mini MAHC relevant terms are included here. Others are in the full 2018 MAHC 3<sup>rd</sup> Edition.*

**"Aquatic Facility"** means a physical place that contains one or more aquatic venues and support infrastructure.

**"Aquatic Feature"** means an individual component within an aquatic venue. Examples include slides, structures designed to be climbed or walked across, and structures that create falling or shooting water.

**"Aquatic Venue"** means an artificially constructed structure or modified natural structure where the general public is exposed to water intended for recreational or therapeutic purpose and where the primary intended use is not watering livestock, irrigation, water storage, fishing, or habitat for aquatic life. Such structures do not necessarily contain standing water, so water exposure may occur via contact, ingestion, or aerosolization. Examples include swimming pools, wave pools, lazy rivers, surf pools, spas (*including spa pools and hot tubs*), therapy pools, waterslide landing pools, spray pads, and other interactive water venues.

**"Certified, Listed, and Labeled"** means equipment, materials, products, or services included in a list published by an ANSI accredited certification organization where said equipment, material, product, or service is evaluated against specific criteria and whose listing either states that it meets identified standards or has been tested and found suitable for a specified purpose. In sections of this code where equipment, materials, products, or services are referred to with terms such as "approved", "verified" or similar terms to a referenced standard, these terms also mean "certified, listed, and labeled."

**"Chlorine"** means an element that at room temperature and pressure is a heavy greenish yellow gas with a characteristic penetrating and irritating smell; it is extremely toxic. It can be compressed in liquid form and stored in heavy steel tanks. When mixed with water, chlorine gas forms hypochlorous acid (HOCl), the primary chlorine-based disinfecting agent, hypochlorite ion, and hydrochloric acid. HOCl dissociation to hypochlorite ion is highly pH dependent. Chlorine is a general term used in the MAHC which refers to HOCl and hypochlorite ion in aqueous solution derived from chlorine gas or a variety of chlorine-based disinfecting agents.

**"Code"** means a systematic statement of a body of law, especially one given statutory force.

**"CT Inactivation Value"** means a representation of the concentration of the disinfectant (*C*) multiplied by time in minutes (*T*) needed for inactivation of a particular contaminant. The concentration and time are

inversely proportional; therefore, the higher the concentration of the disinfectant, the shorter the contact time required for inactivation. The CT Value can vary with pH or temperature change so these values must also be supplied to allow comparison between values.

**“Disinfection”** means a treatment that kills or irreversibly inactivates microorganisms (*e.g., bacteria, viruses, and parasites*); in water treatment, a chemical (*commonly chlorine, chloramine, or ozone*) or physical process (*e.g., ultraviolet radiation*) can be used.

**“Free Chlorine Residual”** means the portion of the total available chlorine that is not “combined chlorine” and is present as HOCl or hypochlorite ion (*OCl<sup>-</sup>*). The pH of the water determines the relative amounts of HOCl and hypochlorite ion. HOCl is a very effective bactericide and is the active bactericide in pool water. OCl<sup>-</sup> is also a bactericide, but acts more slowly than HOCl. Thus, chlorine is a more effective bactericide at low pH than at high pH. A free chlorine residual must be maintained for adequate disinfection.

**“Hyperchlorination”** means the intentional and specific raising of chlorine levels for a prolonged period of time to inactivate pathogens following a fecal or vomit release in an aquatic venue as outlined in MAHC 6.5.

**“Increased Risk Aquatic Venue”** means an aquatic venue which due to its intrinsic characteristics and intended users has a greater likelihood of affecting the health of the bathers of that venue by being at increased risk for microbial contamination (*e.g., by children less than 5 years old*) or being used by people that may be more susceptible to infection (*e.g., therapy patients with open wounds*). Examples of increased-risk aquatic venues include spray pads, wading pools and other aquatic venues designed for children less than 5 years old as well as therapy pools.

**“Interactive Water Play Aquatic Venue”** means any indoor or outdoor installation that includes sprayed, jetted or other water sources contacting bathers and not incorporating standing or captured water as part of the bather activity area. These aquatic venues are also known as splash pads, spray pads, wet decks. For the purposes of the MAHC, only those designed to recirculate water and intended for public use and recreation shall be regulated.

**“Monitor”** means the regular and purposeful observation and checking of systems or facilities and recording of data, including system alerts, excursions from acceptable ranges, and other facility issues. Monitoring includes human or electronic means.

**“Oocyst”** means the thick-walled, environmentally resistant structure released in the feces of infected animals that serves to transfer the infectious stages of sporozoan parasites (*e.g., Cryptosporidium*) to new hosts.

**“Oxidation Reduction Potential” (ORP)** means a measure of the tendency for a solution to either gain or lose electrons; higher (*more positive*) oxidation reduction potential indicates a more oxidative solution.

**“Patron”** means a bather or other person or occupant at an aquatic facility who may or may not have contact with aquatic venue water either through partial or total immersion. Patrons may not have contact with aquatic venue water, but could still be exposed to potential contamination from the aquatic facility air, surfaces, or aerosols.

**“Qualified Operator”** means an individual responsible for the operation and maintenance of the water and air quality systems and the associated infrastructure of the aquatic facility and who has successfully completed an AHJ-recognized operator training course to operate an aquatic facility offered by an AHJ-recognized training agency and holds a current certificate for such training.

**“Recirculation System”** means the combination of the main drain, gutter or skimmer, inlets, piping, pumps, controls, surge tank or balance tank to provide pool water recirculation to and from the pool and the treatment systems.

**“Reduction Equivalent Dose (RED) bias”** means a variable used in UV system validation to account for differences in UV sensitivity between the UV system challenge microbe (e.g., MS2 virus) and the actual microbe to be inactivated (e.g., *Cryptosporidium*).

**“Responsible Supervisor”** means an individual on-site that is responsible for water treatment operations when a “qualified operator” is not on-site at an aquatic facility.

**“Secondary Disinfection Systems”** means those disinfection processes or systems installed in addition to the standard systems required on all aquatic venues, which are required to be used for increased risk aquatic venues.

**“Standard”** means something established by authority, custom, or general consent as a model or example.

**“Substantial Alteration”** means the alteration, modification, or renovation of an aquatic venue (*for outdoor aquatic facilities*) or indoor aquatic facility (*for indoor aquatic facilities*) where the total cost of the work exceeds 50% of the replacement cost of the aquatic venue (*for outdoor aquatic facilities*) or indoor aquatic facility (*for indoor aquatic facilities*).

**“Supplemental Treatment Systems”** means those disinfection processes or systems which are not required on an aquatic venue for health and safety reasons. They may be used to enhance overall system performance and improve water quality.

**“Therapy Pool”** means a pool used exclusively for aquatic therapy, physical therapy, and/or rehabilitation to treat a diagnosed injury, illness, or medical condition, wherein the therapy is provided under the direct supervision of a licensed physical therapist, occupational therapist, or athletic trainer. This could include wound patients or immunocompromised patients whose health could be impacted if there is not additional water quality protection.

**“Wading Pool”** means any pool used exclusively for wading and intended for use by young children where the depth does not exceed 2 feet (*0.6 m*).

## 4.0<sup>A</sup> Aquatic Facility Design Standards and Construction

The provisions of MAHC Chapter 4 (*Aquatic Facility Design Standards and Construction*) apply to construction of a new AQUATIC FACILITY or AQUATIC VENUE or SUBSTANTIAL ALTERATION to an existing AQUATIC FACILITY or AQUATIC VENUE, unless otherwise noted.

### 4.7 Recirculation and Water Treatment

#### 4.7.1 Recirculation Systems and Equipment

##### 4.7.1.2<sup>A</sup> Combined Aquatic Venue Treatment

**4.7.1.2.1** *Maintain and Measure* When treatment systems of multiple AQUATIC VENUES are combined, the design shall include all appurtenances to maintain and measure the required water characteristics including but not limited to flow rate, pH, and DISINFECTANT concentration in each AQUATIC VENUE or AQUATIC FEATURE.

**4.7.1.2.2** *Secondary Disinfection* If SECONDARY DISINFECTION is required for an INCREASED RISK AQUATIC VENUE as per MAHC 4.7.3.3.1.2, then SECONDARY DISINFECTION shall be required for all treatment systems that are combined with the INCREASED RISK AQUATIC VENUE.

**4.7.1.2.3** *Isolate* When multiple AQUATIC VENUES are combined in one treatment system, each AQUATIC VENUE shall be capable of being isolated for maintenance purposes.

#### 4.7.3<sup>A</sup> Disinfection and pH Control

##### 4.7.3.3 Secondary Disinfection Systems

###### 4.7.3.3.1 General Requirements

**4.7.3.3.1.1<sup>A</sup>** *ANSI Listing and Labeling* SECONDARY DISINFECTION SYSTEMS shall be CERTIFIED, LISTED, AND LABELED to ANSI/NSF 50 by an ANSI-accredited certification organization approved by the AHJ.

**4.7.3.3.1.1.1** *Marked* SECONDARY DISINFECTION SYSTEM equipment shall be marked with an EPA establishment number.

**4.7.3.3.1.2<sup>A</sup>** *Required Facilities* The new construction or SUBSTANTIAL ALTERATION of the following INCREASED RISK AQUATIC VENUES shall be required to use a SECONDARY DISINFECTION SYSTEM after adoption of this CODE:

- 1) AQUATIC VENUES designed primarily for children under 5 years old, such as
  - a. WADING POOLS,
  - b. INTERACTIVE WATER PLAY VENUES with no standing water, and
- 2) THERAPY POOLS.

**4.7.3.3.1.3** *Other Aquatic Venues* Optional SECONDARY DISINFECTION SYSTEMS may be installed on other AQUATIC VENUES not specified in MAHC 4.7.3.3.1.2.

**4.7.3.3.1.4** *Labeled* If installed and labeled as SECONDARY DISINFECTION SYSTEMS, then they shall conform to all requirements specified under MAHC 4.7.3.3.

**4.7.3.3.1.5** *Conform* If not labeled as SECONDARY DISINFECTION SYSTEMS, then they shall be labeled as SUPPLEMENTAL TREATMENT SYSTEMS and conform to requirements listed under MAHC 4.7.3.4.

#### **4.7.3.3.2<sup>A</sup> Log Inactivation and Oocyst Reduction**

**4.7.3.3.2.1<sup>A</sup> Log Inactivation** SECONDARY DISINFECTION SYSTEMS shall be designed to achieve a minimum 3-log (99.9%) reduction in the number of infective *Cryptosporidium parvum* OOCYSTS per pass through the SECONDARY DISINFECTION SYSTEM for INTERACTIVE WATER PLAY AQUATIC VENUES and a minimum 2-log (99%) reduction per pass for all other AQUATIC VENUES requiring SECONDARY DISINFECTION.

**4.7.3.3.2.2<sup>A</sup> Installation** The SECONDARY DISINFECTION SYSTEM shall be located in the treatment loop (post filtration) and treat a portion (up to 100%) of the filtration flow prior to return of the water to the AQUATIC VENUE or AQUATIC FEATURE.

**4.7.3.3.2.3 Manufacturer's Instructions** The SECONDARY DISINFECTION SYSTEM shall be installed according to the manufacturer's directions.

**4.7.3.3.2.4<sup>A</sup> Minimum Flow Rate Calculation** The flow rate (Q) through the SECONDARY DISINFECTION SYSTEM shall be determined based upon the total volume of the AQUATIC VENUE or AQUATIC FEATURE (V) and a prescribed dilution time (T) for theoretically reducing the number of assumed infective *Cryptosporidium* OOCYSTS from an initial total number of 100 million (10<sup>8</sup>) OOCYSTS to a concentration of 1 OOCYST/100 mL.

**4.7.3.3.2.5<sup>A</sup> Equation** Accounting for a 3-log (99.9%) or 2-log (99%) reduction of infective *Cryptosporidium* OOCYSTS through the SECONDARY DISINFECTION SYSTEM with each pass, the SECONDARY DISINFECTION SYSTEM flow rate (Q) shall be:

- 1)  $Q = V \times \{[14.8 - \ln(V)] / (r \times 60 \times T)\}$ , where:
  - Q = SECONDARY DISINFECTION SYSTEM flow rate (gpm)
  - V = Total water volume of the AQUATIC VENUE or AQUATIC FEATURE, including surge tanks, piping, equipment, etc. (gals)
  - r = Efficiency of the system (r = 0.999 for 3-log reduction, r = 0.99 for 2-log reduction)
  - T = Dilution time (hrs.)

**4.7.3.3.2.6 Time for Dilution Reduction** The dilution time shall be the lesser of nine hours or 75% of the uninterrupted time an AQUATIC VENUE is closed in a 24 hour period.

**4.7.3.3.2.7<sup>A</sup> Flow Rate Measurements** Where a SECONDARY DISINFECTION SYSTEM is installed, a means shall be installed to confirm the required flow rate to maintain a minimum required log inactivation of infective *Cryptosporidium* OOCYSTS at the minimum flow rate.

**4.7.3.3.2.7.1 Flow Rate Defined** The minimum required flow rate through the SECONDARY DISINFECTION SYSTEM shall be as defined in MAHC 4.7.3.3.2.5.

**4.7.3.3.3<sup>A</sup> Ultraviolet Light Systems** To prevent mercury exposure, UV systems shall be installed to avoid lamp breakage according to the guidelines in EPA 815-R-06-007, Appendix E.

**4.7.3.3.3.1<sup>A</sup> Third Party Validation** UV equipment shall be third party validated in accordance with the practices outlined in the US EPA Ultraviolet Disinfectant Guidance Manual dated November, 2006, publication number EPA 815-R-06-007.

**4.7.3.3.3.1.1<sup>A</sup> Validation Standard** The US EPA Ultraviolet Disinfectant Guidance Manual shall be considered a recognized national STANDARD in the MAHC.

**4.7.3.3.3.2 Suitable for Intended Use** UV systems and all materials used therein shall be suitable for their intended use and be installed:

- 1) In accordance with the MAHC,
- 2) As listed and labeled to a specific STANDARD by an ANSI-accredited certification organization, and
- 3) As specified by the manufacturer.

- 4.7.3.3.3.3 Installation** The UV equipment shall be installed after the filtration and before addition of primary DISINFECTANT.
- 4.7.3.3.3.3.1 Labeled** UV equipment shall be labeled with the following design specifications: maximum flow rate, minimum transmissivity, minimum intensity, and minimum dosage.
- 4.7.3.3.3.3.2 Strainer Installation** An inline strainer shall be installed after the UV unit to capture broken lamp glass or sleeves.
- 4.7.3.3.3.4 Electrically Interlocked** The equipment shall be electrically interlocked with feature pump(s) or automated feature supply valves, such that when the UV equipment fails to produce the required dosage as measured by automated sensor, the water features do not operate.
- 4.7.3.3.3.4.1<sup>A</sup> Alarm/Interlock Setpoint** The UV alarm/interlock setpoint shall be such that it ensures that the minimum required dose is delivered under all possible conditions of water UV transmittance and lamp output at the actual flow rate.
- 4.7.3.3.3.4.2 Operation** UV systems shall not operate if the RECIRCULATION SYSTEM is not operating.
- 4.7.3.3.3.5 Calibrated UV Sensors** The UV equipment shall be complete with calibrated UV sensors, which record the output of all the UV lamps installed in a system.
- 4.7.3.3.3.5.1 Multiple Lamps** Where multiple lamps are fitted, sufficient sensors shall be provided to measure each lamp.
- 4.7.3.3.3.5.2 Fewer Sensors** If the design utilizes fewer sensors than lamps, the location of lamps and sensors shall be such that the output of all lamps is adequately measured.
- 4.7.3.3.3.6 Automated Shut Down** The automated shut down of the UV equipment for any reason shall initiate a visual alarm or other indication which will alert staff on-site or remotely.
- 4.7.3.3.3.6.1 Signage** Signage instructing staff or PATRONS to notify facility management shall be posted adjacent to the visual indication.
- 4.7.3.3.3.6.2 Not Staffed** If the AQUATIC FACILITY is not staffed, the sign shall include a means to contact management whenever the AQUATIC FACILITY is in use.
- 4.7.3.3.3.7 Reports and Documentation** The UV equipment shall be supplied with the appropriate validation reports and documentation for that equipment model.
- 4.7.3.3.3.8 Manufacturer Log Inactivation Chart** This documentation will include a graph or chart indicating the dose at which the required log inactivation is guaranteed for the system in question.
- 4.7.3.3.3.8.1 Reduction Equivalent Dose Bias** This dose shall be inclusive of validation factors and RED BIAS.
- 4.7.3.3.3.8.2 System Performance Curves** System performance curves that do not include such factors are not considered validated systems.
- 4.7.3.3.3.9<sup>A</sup> Minimum RED** Validation records shall include the graph indicating the minimum intensity reading required at the operational flow for the minimum RED required to achieve the required log reduction.
- 4.7.3.3.3.9.1 Minimum Intensity Shown** Where systems are validated to a specific dose, the graph shall show the minimum intensity reading required at the operational flow for that dose.
- 4.7.3.3.3.10 Recommended Validation Protocol** Based on the recommended validation protocol presented in the US EPA Disinfection Guidance Manual, UV reactors certified by ÖNORM and DVGW for a *Bacillus subtilis* RED of 40mJ/cm<sup>2</sup> shall be granted 3-Log *Cryptosporidium* and 3-log *Giardia* inactivation credit as required in this CODE.

#### **4.7.3.3.4 Ozone Disinfection**

**4.7.3.3.4.1<sup>A</sup> Log Inactivation** SECONDARY DISINFECTION SYSTEMS using ozone shall provide the required inactivation of *Cryptosporidium* in the full flow of the SECONDARY DISINFECTION SYSTEM after any side-stream has remixed into the full flow of the SECONDARY DISINFECTION SYSTEM.

**4.7.3.3.4.2<sup>A</sup> Third Party Validation** Ozone systems shall be validated by an ANSI-accredited third party testing and certification organization to confirm that they provide the required log inactivation of *Cryptosporidium* in the full SECONDARY DISINFECTION SYSTEM flow after any side-stream has remixed into the full SECONDARY DISINFECTION SYSTEM flow and prior to return of the water to the AQUATIC VENUE or AQUATIC FEATURE recirculation treatment loop.

**4.7.3.3.4.3<sup>A</sup> Suitable for Use** Ozone systems and all materials used therein shall be suitable for their intended use and be installed:

- 1) In accordance with all applicable requirements,
- 2) As CERTIFIED, LISTED, AND LABELED to a specific STANDARD by an ANSI-accredited certification organization, and
- 3) As specified by the manufacturer.

**4.7.3.3.4.4 Ozone System Components** An ozone system shall be a complete system consisting of the following (*either skid-mounted or components*):

- 1) Ozone generator,
- 2) Injector / injector manifold,
- 3) Reaction tank (*contact tank*) / mixing tank / degas tower,
- 4) Degas valve (*if applicable, to vent un-dissolved gaseous ozone*),
- 5) Ozone destruct (*to destroy un-dissolved gaseous ozone*),
- 6) ORP MONITOR / controller,
- 7) Ambient ozone MONITOR / controller,
- 8) Air flow meter / controller, and
- 9) Water BACKFLOW prevention device in gas delivery system.

**4.7.3.3.4.5 Appropriate Installation** These components (*or skid*) shall be installed as specified by the manufacturer to maintain the required system validation as noted above.

**4.7.3.3.4.6 ORP Monitor** The ozone generating equipment shall be designed, sized, and controlled utilizing an ORP MONITOR / controller (*independent of and in addition to any halogen ORP MONITOR/controller*).

**4.7.3.3.4.6.1 Placed Downstream** The device shall be placed in the AQUATIC VENUE and AQUATIC FEATURE recirculation water downstream of the ozone side-stream loop and before the halogen feed location.

**4.7.3.3.4.6.2 Minimum ORP Reading** The minimum ORP reading shall be no less than 600 mV measured directly after [*one to 5 feet (30.5 cm to 1.5 m)*] the ozone side-stream remixes into the full flow of the RECIRCULATION SYSTEM.

**4.7.3.3.4.6.3 Maximum ORP Reading** The maximum ORP reading shall be no greater than 900 mV.

**4.7.3.3.4.7 Installation and Injection Point** The ozone system injection point shall be located in the AQUATIC VENUE return line after the filtration and heating equipment, prior to the primary DISINFECTANT injection point.

**4.7.3.3.4.7.1 Injection and Mixing** The injection and mixing system shall not prevent the attainment of the recirculation rate required elsewhere in this CODE.

- 4.7.3.3.4.7.2<sup>A</sup>**                    **Gas Monitor / Controller** An ambient ozone gas MONITOR/controller located adjacent to the ozone reactor/contact tank shall be utilized to disable the ozone system in the event of an ozone gas leak.
- 4.7.3.3.4.8**                    **Comply with Fire Code** Ozone system installations shall comply with the NFPA 1 Fire Code or the International Fire Code and any other CODES, STANDARDS, or requirements as mandated by the AHJ.
- 4.7.3.3.4.9**                    **Air Space Testing** At the time the ozone generating equipment is installed, again after 24 hours of operation, and annually thereafter, the air space within 6 inches of the AQUATIC VENUE water shall be tested to determine compliance of less than 0.1 ppm (mg/L) gaseous ozone.
- 4.7.3.3.4.9.1**                    **Results** Results of the test shall be maintained on site for review by the AHJ.
- 4.7.3.3.4.10**                    **Automatic Shut Down** Automatic shutdown shall occur under any condition that would result in the ozone system not operating within the established parameters needed to achieve the required log inactivation of *Cryptosporidium* (*i.e. low feed gas supply, loss of vacuum or pressure, high dew point in feed air, water in ozone gas delivery line*).
- 4.7.3.3.4.10.1**                    **Electrically Interlocked** The equipment shall be electrically interlocked with AQUATIC VENUE pump(s) or automated feature supply valves, such that when the ozone equipment fails to produce the required dosage as measured by ORP, the AQUATIC VENUES do not operate.
- 4.7.3.3.4.11**                    **ORP Reading Alarm or Visual Indication** If the ORP reading for the ozone system drops below 600 mV (*regardless of the cause*) a visual alarm or other indication shall be initiated that will alert staff on-site or remotely.
- 4.7.3.3.4.11.1**                    **Signage** Signage to notify facility management shall be present adjacent to the visual alarm.
- 4.7.3.3.4.12**                    **Regular Audits** In order to ensure that the supplied ozone system meets all the requirements of the STANDARD, the manufacturer shall maintain a quality system audited on a regular basis to a recognized quality STANDARD.
- 4.7.3.3.4.12.1**                    **Listed** Ozone equipment shall be listed to NSF/ANSI Standard 50.1.
- 4.7.3.3.4.13**                    **Reports and Documentation** The ozone system shall be supplied with the appropriate validation reports and documentation for that equipment model.
- 4.7.3.3.4.13.1**                    **Log Inactivation Chart** Ozone validation reports shall include a graph, chart, or other documentation which clearly indicates the required operating parameters for which the required log inactivation is guaranteed for the system in question.
- 4.7.3.3.4.13.2**                    **Inclusive** This dose shall be inclusive of validation factors.
- 4.7.3.3.4.13.3**                    **System Performance Curves** System performance curves that do not include such factors are not considered validated systems.

## 5.0<sup>A</sup> Aquatic Facility Operation and Maintenance

### 5.7 Recirculation and Water Treatment

**5.7.3 Water Treatment Chemicals and Systems** Treatment chemicals shall be CERTIFIED, LISTED, AND LABELED to either NSF/ANSI Standard 50 or NSF/ANSI Standard 60 by an ANSI-accredited certification organization, and/or have an EPA FIFRA registration and be used only in accordance with the manufacturer's instructions.

#### 5.7.3.2<sup>A</sup> Secondary or Supplemental Treatment Systems

##### 5.7.3.2.1 Ultraviolet Light

**5.7.3.2.1.1 Operate with Recirculation System** UV systems shall only operate while the RECIRCULATION SYSTEM is operating.

**5.7.3.2.1.2<sup>A</sup> Log Inactivation** Secondary UV systems shall be operated and maintained not to exceed the maximum validated flow rate and meet or exceed the minimum validated output intensity needed to achieve the required dose.

##### 5.7.3.2.2 Ozone

**5.7.3.2.2.1 Log Inactivation** Ozone systems shall be operated and maintained according to the manufacturer's instructions to maintain the required design performance.

#### 5.7.3.7 Automated Controllers and Equipment Monitoring

**5.7.3.7.7<sup>A</sup> Ozone System** When an ozone system is utilized as a SECONDARY DISINFECTION SYSTEM, the system shall be MONITORED and data recorded at a frequency consistent with MAHC Table 5.7.3.7.7.

**Table 5.7.3.7.7: Ozone System Monitoring Frequency**

Parameter	Monitoring Frequency	Recording Frequency
ORP	Continuous	Every 4 hours
Control System Indicating Ozone Being Created	Continuous	Every 4 Hours
Operational Indicators in Range	Continuous	Every 4 hours
Ozone Within 6 inches of Aquatic Venue Water Surface	Annual	Annual

**5.7.3.7.8<sup>A</sup> UV Systems** When a UV system is utilized as a SECONDARY DISINFECTION SYSTEM, the system shall be MONITORED and data recorded at a frequency consistent with MAHC Table 5.7.3.7.8.

**Table 5.7.3.7.8: UV System Monitoring and Calibration Frequency**

Parameter	Monitoring Frequency	Recording Frequency
Flow Rate Monitoring	Continuous	Every 4 Hours
Intensity Monitoring	Continuous	Every 4 Hours
Water Temperature Monitoring ( <i>Medium Pressure</i> )	Continuous	Daily
Set Point for Intensity Monitoring	Continuous	Daily
UV Lamp On/Off Cycle Monitoring	Continuous	Weekly ( <i>Total Cycles/Week</i> )
Iron, Calcium Hardness Monitoring	Weekly ( <i>If Fouling is Prevalent</i> )	Weekly
Calibration of UVT Analyzer ( <i>if used</i> )	Per Manufacturer's Requirements	At Time of Calibration
Calibration of Intensity	Per Manufacturer's Requirements	At Time of Calibration
Calibration of Flow Meter	Per Manufacturer's Requirements	At Time of Calibration

## 6.0<sup>A</sup> Aquatic Facility Policies and Management

### 6.4<sup>A</sup> Aquatic Facility Management

#### 6.4.1 Operations

**6.4.1.3.1 Daily Inspection Items** The QUALIFIED OPERATOR or RESPONSIBLE SUPERVISOR shall ensure that a daily AQUATIC FACILITY preventive maintenance inspection is done before opening and that it shall include:

- 8) Recirculation, DISINFECTION systems, controller(s), and probes are operating as required;
- 9) SECONDARY DISINFECTION SYSTEMS and/or SUPPLEMENTAL TREATMENT SYSTEMS are operating as required;

**6.4.1.6<sup>A</sup> Daily Water Monitoring and Testing Records** Daily, or as often as required, MONITORING and testing records shall include, but are not limited to the following:

- 1) SECONDARY DISINFECTION SYSTEMS as outlined in MAHC 5.7.3.7.7 and 5.7.3.7.8.

### 6.5<sup>A</sup> Fecal/Vomit/Blood Contamination Response

#### 6.5.3 Aquatic Venue Water Contamination Disinfection

**6.5.3.1<sup>A</sup> Formed-Stool Contamination** Formed-stool contaminated water shall have the FREE CHLORINE RESIDUAL checked and the FREE CHLORINE RESIDUAL raised to 2.0 mg/L (if less than 2.0 mg/L) and maintained for at least 25 minutes (or an equivalent time and concentration to reach the CT INACTIVATION VALUE) before reopening the AQUATIC VENUE.

**6.5.3.1.1<sup>A</sup> Pools Containing Chlorine Stabilizers** In AQUATIC VENUE water that contains CYA or a stabilized CHLORINE product, water shall be treated by doubling the inactivation time required under MAHC 6.5.3.1.

**6.5.3.1.2 Measurement of Inactivation Time** Measurement of the inactivation time required shall start when the AQUATIC VENUE reaches the intended free CHLORINE level.

**6.5.3.2<sup>A</sup> Diarrheal-Stool Contamination** Diarrheal-stool contaminated water shall:

- 1) Check the FREE CHLORINE RESIDUAL and then raise the FREE CHLORINE RESIDUAL to 20.0 mg/L and maintain for at least 12.75 hours (or an equivalent time and concentration to reach the CT INACTIVATION VALUE) before reopening the AQUATIC VENUE, or
- 2) Circulate the water through a SECONDARY DISINFECTION SYSTEM to theoretically reduce the number of *Cryptosporidium* OOCYSTS in the AQUATIC VENUE below one OOCYST/100 mL as outlined in MAHC 4.7.3.3.2.4.

**6.5.3.2.1<sup>A</sup> Pools Containing Chlorine Stabilizers** In AQUATIC VENUE water that contains CYA or a stabilized CHLORINE product, water shall be treated by:

- 1) HYPERCHLORINATION accomplished by:
  - a. Following the preparatory guidance outlined in MAHC 6.5.2.3;
  - b. Lowering the CYA concentration to less than or equal to 15 ppm by draining, if necessary;
  - c. Raising the FREE CHLORINE RESIDUAL to 20 mg/L for at least 28 hours; 30 mg/L for at least 18 hours; or 40 mg/L for at least 8.5 hours, which is needed to reach the CT INACTIVATION VALUE; and
  - d. Measuring the inactivation time required, which shall start when the AQUATIC VENUE reaches the intended FREE CHLORINE RESIDUAL level or;
- 2) Circulating the water through a SECONDARY DISINFECTION SYSTEM to theoretically reduce the number of *Cryptosporidium* OOCYSTS in the AQUATIC VENUE below 1 OOCYST/100 mL as outlined in MAHC 4.7.3.3.2.4 or;

- 3) Draining the AQUATIC VENUE completely.