

**Model Aquatic Health Code  
Disinfection and Water Quality Module CODE Draft Sections  
for the First 60-day Review**

**Posted for Public Comment on 02/27/2012  
Currently Open for Public Comment that Closes on 04/27/2012**

*In an attempt to speed the review process along, the MAHC steering committee has decided to release MAHC draft modules prior to their being fully complete and formatted. These drafts will continue to be edited and revised while being posted for public comment. The complete versions of the drafts will also be available for public comment again when all MAHC modules are posted for final public comment. The MAHC committees appreciate your patience with the review process and commitment to this endeavor as we all seek to produce the best aquatic health code possible.*

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## MAHC Disinfection & Water Quality Module Abstract

Disinfection and water quality are critical components in maintaining bather health and comfort. Health issues related to inadequate disinfection and poor water quality are increasingly being documented. Outbreak investigations have often determined that disinfectant levels and other water quality parameters were not maintained appropriately thereby allowing disinfectant-sensitive pathogens to be associated with pool use. The emergence of chlorine-tolerant microbes also necessitates changing accepted standards for pool treatment to protect the health of bathers in the future. The Disinfection and Water Quality Module takes the first steps in addressing these recurring and emerging aquatic health issues. The Disinfection and Water Quality Module contains requirements for new or modified construction that include:

- 1) Primary disinfectant levels set.
- 2) Secondary disinfection required for “increased risk” aquatic venues such as Interactive features, spray pads, wading pools, and other venues designed primarily for diaper-aged children as well as therapy pools
- 3) Combined chlorine maximum levels set
- 4) Prohibition of cyanuric acid in Indoor facilities and “increased risk” aquatic venues

## MAHC Disinfection & Water Quality Module Review Guidance

The **Model Aquatic Health Code (MAHC) Steering** (<http://www.cdc.gov/healthywater/swimming/pools/mahc/steering-committee/>) and **Technical** (<http://www.cdc.gov/healthywater/swimming/pools/mahc/technical-committee/>) **Committees** appreciate your willingness to review this draft MAHC module. Your unique perspectives and science-based suggestions will help ensure that the best available standards and practices for protecting aquatic public health are available for adoption by state and local environmental health programs.

### Review Reminders:

- Please download and use the **MAHC Comment Form** (<http://www.cdc.gov/healthywater/swimming/pools/mahc/structure-content/>) to submit your detailed, succinct comments and suggested edits. Return your review form by 04/27/2012, as an email attachment to [MAHC@cdc.gov](mailto:MAHC@cdc.gov).
- If part of a larger group or organization, please consolidate comments to speed the MAHC response time to public comments.
- To provide context for this module review, please consult the **MAHC Strawman Outline** (<http://www.cdc.gov/healthywater/pdf/swimming/pools/mahc/structure-content/mahc-strawman.pdf>). Section headers of related content have been

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included in this draft module to assist reviewers to see where each section fits into the overall MAHC structure. Additional MAHC draft modules that contain this content will be or already have been posted for your review.

- The complete draft MAHC, with all of the individual module review comments addressed will be posted again for a final review and comment before MAHC publication. This will enable reviewers to review modules in the context of other modules and sections that may not have been possible during the initial individual module review.
- The published MAHC will be regularly updated through a collaborative all-stakeholder process.

Please address any questions you may have about MAHC or the review process to [MAHC@cdc.gov](mailto:MAHC@cdc.gov). You may also request to be on the direct email list for alerts (“Get Email Updates” is in a box on the right hand side of the Healthy Swimming website at [www.cdc.gov/healthyswimming](http://www.cdc.gov/healthyswimming)) on the other draft MAHC modules as they are released for public comment.

Thank you again, and we look forward to your help in this endeavor.  
Sincerely,

Douglas C. Sackett, Director  
MAHC Steering Committee

The Disinfection & Water Quality Code Module shows a Table of Contents giving the context of the Disinfection & Water Quality Design, Construction, Operation and Maintenance in the overall Model Aquatic Health Code’s Strawman Outline (<http://www.cdc.gov/healthywater/pdf/swimming/pools/mahc/structure-content/mahc-strawman.pdf>).

***Reviewer Note on Module Section Numbering:***

Please use the specific section numbers to make your comments on this Draft Model Aquatic Health Code module. These numbers may eventually change during the editing of the compiled Draft that will be issued for a final round of comments.

**MAHC Strawman**

- 1.0 Preface
- 2.0 User Guide
- 3.0 Definitions
- 4.0 Design Standards and Construction

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- 5.0 Operation and Maintenance
- 6.0 Policies and Management
- 7.0 Index
- 8.0 Annexes
- 9.0 Summary of Changes

## **4.0 Design Standards and Construction**

- 4.1 Plan Submittal
- 4.2 Materials
- 4.3 Equipment Standards
- 4.4 Pool Operation and Facility Maintenance [N/A]
- 4.5 Pool Structure (Shell)
- 4.6 Indoor/Outdoor Environment
- 4.7 Recirculation and Water Treatment
  - 4.7.1 Recirculation Systems and Equipment
  - 4.7.2 Filtration
  - 4.7.3 Disinfection**
    - 4.7.3.1 Primary Disinfectants
    - 4.7.3.2 Stabilizers
    - 4.7.3.3 Secondary Disinfection Systems**
      - 4.7.3.3.1 General Requirements**
      - 4.7.3.3.2 3-log Inactivation**
      - 4.7.3.3.3 UV**
      - 4.7.3.3.4 Ozone**
    - 4.7.3.4 Supplemental Treatment Systems**
      - 4.7.3.4.1 General Requirements**
      - 4.7.3.4.2 UV**
      - 4.7.3.4.3 Ozone**
      - 4.7.3.4.4 Copper / Silver Ion**
      - 4.7.3.4.5 UV / Peroxide**
    - 4.7.3.5 pH
    - 4.7.3.6 Levels
    - 4.7.3.7 Feed Equipment
    - 4.7.3.8 Controllers
    - 4.7.3.9 Test Kits
  - 4.7.4 Water Quality [N/A]
- 4.8 Decks and Equipment
- 4.9 Filter/Equipment Room
- 4.10 Hygiene Facilities (Bathhouse)
- 4.11 Water Supply/Wastewater Disposal
- 4.12 Specific Venues - Special Requirements

## **5.0 Operation and Maintenance**

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- 5.1 Plan Submittal [N/A]
- 5.2 Materials [N/A]
- 5.3 Equipment Standards [N/A]
- 5.4 Pool Operation and Facility Maintenance
- 5.5 Pool Structure (Shell)
- 5.6 Indoor/Outdoor Environment
- 5.7 Recirculation and Water Treatment
  - 5.7.1 Recirculation Systems and Equipment
  - 5.7.2 Filtration
  - 5.7.3 Disinfection**
    - 5.7.3.1 Primary Disinfectants**
      - 5.7.3.1.1 Chlorine (Ca/Na/Li Hypochlorite)
      - 5.7.3.1.2 Bromine
    - 5.7.3.2 Stabilizers**
      - 5.7.3.2.1 Cyanuric Acid
    - 5.7.3.3 Secondary Disinfection Systems**
      - 5.7.3.3.1 General [N/A]
      - 5.7.3.3.2 3-Log Inactivation [N/A]
      - 5.7.3.3.3 UV**
      - 5.7.3.3.4 Ozone**
    - 5.7.3.4 Supplemental Treatment Systems**
      - 5.7.3.4.1 General**
      - 5.7.3.4.2 UV**
      - 5.7.3.4.3 Ozone**
      - 5.7.3.4.4 Copper/Silver**
    - 5.7.3.5 pH**
    - 5.7.3.6 Levels
    - 5.7.3.7 Feed Equipment
    - 5.7.3.8 Controllers
    - 5.7.3.9 Test Kits
  - 5.7.4 Water Quality
    - 5.7.4.1 Sample Collection and Analysis
    - 5.7.4.2 Microbiological Quality
    - 5.7.4.3 Chemical Quality
      - 5.7.4.3.1 Physiological Effects to Bathers
      - 5.7.4.3.2 Total Alkalinity Level**
      - 5.7.4.3.3 Pool Water Chemical Balance**
      - 5.7.4.3.4 Total Dissolved Solids**
      - 5.7.4.3.5 Source Water**
    - 5.7.4.4 Saturation Index for Swimming Pools**
    - 5.7.4.5 Water Clarity – Secchi Disk, Main Drain Visible
    - 5.7.4.6 Water Temperature**
- 5.8 Decks and Equipment

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- 5.9 Filter/Equipment Room
- 5.10 Hygiene Facilities (Bathhouse)
- 5.11 Water Supply/Wastewater Disposal
- 5.12 Specific Venues - Special Requirements

### Acronyms in this Module:

AHJ	Authority having jurisdiction
ANSI	American National Standards Institute
CYA	Cyanuric Acid
DVGW	Deutscher Verein des Gas- und Wasserfaches e.V. – Technisch wissenschaftlicher Verein (German Technical and Scientific Association for Gas and Water)
EPA	Environmental Protection Agency
FAC	Free available chlorine
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GPM	Gallons per minute
NSF	National Sanitation Foundation
ÖNORM	Österreichisches Normungsinstitut (Austrian Standards Institute)
ORP	Oxidation reduction potential
PPM	Parts per million
RED	Reduction Equivalent Dose
RWI	Recreational Water Illness
SDS	Secondary Disinfection System
TDS	Total Dissolved Solids
UV	Ultraviolet

### Glossary Terms in this Module:

“**Aquatic Facility**” means a physical place that contains one or more aquatic venues and support infrastructure under a single management structure.

“**Aquatic Feature**” means an individual recreational component within an aquatic venue. Examples include mushrooms, slides, buckets, and spray guns/nozzles.

“**Aquatic Venue**” means an artificially constructed or modified natural structure where the general public is exposed to water intended for recreational or therapeutic purpose. Such structures do not necessarily contain standing water so water exposure may occur via contact, ingestion, or aerosolization. Examples include swimming pools, wave pool, river, spas (including spa pools and hot tubs), therapeutic pools, and spray pads.

“**Authority Having Jurisdiction**” (AHJ) means an agency, organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

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**“Bather”** means a person at an aquatic venue who has contact with water either through spray or partial or total immersion. Bathers can be exposed to contaminated water as well as potentially contaminate the water.

**“Chlorine”** means an element that at room temperature and pressure is a heavy green gas with characteristic odor and is extremely toxic. It can be compressed in liquid form and stored in heavy steel tanks, but most pools now add other chlorine compounds (e.g. hypochlorite) that release hypochlorous acid when dissolved in water. Chlorinating agents are the most commonly used disinfectants for pools.

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

**“Disinfection”** means a treatment that kills 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.

**“EPA Registered”** means all pesticide products regulated and registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) by the U.S. Environmental Protection Agency (EPA; <http://www.epa.gov/agriculture/lfra.html>). EPA registered products will have a registration number on the label (usually it will state “EPA Reg No.” followed by a series of numbers). This registration number can be verified by using the EPA National Pesticide Information Retrieval System (<http://ppis.ceris.purdue.edu/#>)

**“Free Available Chlorine”** means the available disinfectant in the water. It is the portion of total chlorine that is not combined chlorine and is available as effective disinfectant. When chlorine is added to water, hypochlorous acid is produced in either the molecular state (HOCl) or the ionized state (hypochlorite ion (OCl<sup>-</sup>) plus hydrogen ion (H<sup>+</sup>)), and a by-product specific to the type of chlorine is produced. The pH of the water determines the amount of hypochlorous acid in each state. HOCl is a very effective bactericide and is the active available chlorine disinfectant in the water. OCl<sup>-</sup> is also a bactericide, but acts more slowly than HOCl. Thus chlorine is a much less effective bactericide at high pH. The sum of HOCl and OCl<sup>-</sup> is referred to as “free chlorine” in pool water. The hypochlorous acid that remains in pool water uncombined with ammonia is called “free available chlorine”. A free available chlorine residual must be maintained for adequate disinfection.

**“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 and safety of the patrons of that venue by being at increased risk for contamination (e.g., by diaper-aged children/children aged <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 diaper-aged children as well as therapy pools.

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“**mg/L**” means milligrams per liter, the equivalent metric measure to parts per million (ppm).

“**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**” means the process of changing the chemical structure of water contaminants by increasing the number of oxygen atoms or reducing the number of electrons of the contaminant, which allows the contaminant to be more readily altered, inactivated, or removed from the water. It is the “chemical cleaning” of pool water. Oxidation can be achieved by common disinfectants (e.g., chlorine, bromine, ozone, potassium monopersulfate).

“**pH**” means a symbol that expresses the negative log of the concentration of hydrogen ions. When water ionizes, it produces hydrogen ions (H+) and hydroxide ions (OH-). If there is an excess of hydrogen ions the water is acidic. If there is an excess of hydroxide ions the water is basic. pH ranges from 0 to 14. Pure water has a pH of 7.0. If pH is higher than 7.0, the water is said to be basic, or alkaline. If the water’s pH is lower than 7.0, the water is acidic. As pH is raised, more ionization occurs and chlorine-based disinfectants decrease in effectiveness.

“**Pool**” means a subset of aquatic venues designed to have captured water for total or partial bather immersion.

“**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*).

“**Secondary disinfection systems**” means those disinfection processes or systems which are required to be used for “increased risk aquatic venues” to meet the minimum standards of this code and are in addition to the requirements of Section 5.0 of this code.

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

***Preface:*** *This document does not address all health and safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to each use.*

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## Model Aquatic Health Code Disinfection & Water Quality Code 4.0 Design Standards and Construction

Keyword	Section	Code	Grade
	<b>4.0</b>	<b>Design and Construction</b>	
	<b>4.1</b>	<b>Plan Submittal</b>	
	<b>4.2</b>	<b>Materials</b>	
	<b>4.3</b>	<b>Equipment Standards</b>	
	<b>4.4</b>	<b>Pool Operation and Facility Maintenance</b>	
	<b>4.5</b>	<b>Pool Structure (Shell)</b>	
	<b>4.6</b>	<b>Indoor/Outdoor Environment</b>	
	<b>4.7</b>	<b>Recirculation and Water Treatment</b>	
	<b>4.7.1</b>	<b>Recirculation Systems and Equipment</b>	
	<b>4.7.2</b>	<b>Filtration</b>	
	<b>4.7.3</b>	<b>Disinfection</b>	
	<b>4.7.3.1</b>	<b>Oxidants</b>	
	<b>4.7.3.2</b>	<b>Stabilizers</b>	
	<b>4.7.3.3</b>	<b>Secondary Disinfection Systems</b>	
	<b>4.7.3.3.1</b>	<b>General Requirements</b>	
<i>ANSI Certified</i>	4.7.3.3.1.1	SECONDARY DISINFECTION SYSTEMS shall be certified to ANSI/NSF 50 by an ANSI-Accredited third-party testing and certification organization.	
<i>Required Facilities</i>	4.7.3.3.1.2	The new construction or substantial renovation of the following INCREASED RISK AQUATIC VENUES shall be required to use a SECONDARY DISINFECTION SYSTEM after adoption of this CODE: <ol style="list-style-type: none"> <li>1) AQUATIC VENUES designed primarily for diaper-aged children (children &lt;5 years old), such as                             <ol style="list-style-type: none"> <li>a. wading POOLS,</li> <li>b. water activity POOLS,</li> <li>c. interactive water features with no standing water,</li> <li>d. SPRAY PADS, and</li> </ol> </li> <li>2) Therapy pools</li> </ol>	
<i>Other Aquatic Venues</i>	4.7.3.3.1.3	Optional SECONDARY DISINFECTION SYSTEMS	

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Keyword	Section	Code	Grade
		may be installed on other aquatic venues not specified in 4.7.3.3.1.2.	
Labeled	4.7.3.3.1.4	If installed and labeled as SECONDARY DISINFECTION SYSTEMS, then they shall conform to all requirements specified under 4.7.3.3.	
Conform	4.7.3.3.1.5	If not labeled as SECONDARY DISINFECTION SYSTEMS, then they shall be labeled as SUPPLEMENTAL TREATMENT SYSTEMS and conform to requirements listed under 4.7.3.4.	
	<b>4.7.3.3.2</b>	<b>3-log Inactivation and Oocyst Reduction</b>	
3-log Inactivation	4.7.3.3.2.1	SECONDARY DISINFECTION SYSTEMS shall be designed to achieve a minimum 3-log (99.9%) reduction in the number of infective <i>Cryptosporidium parvum</i> oocysts per pass through the SECONDARY DISINFECTION SYSTEM.	
Theoretical Oocyst Reduction	4.7.3.3.2.2	The SECONDARY DISINFECTION SYSTEM shall also be designed to reduce a theoretical total number of infective <i>Cryptosporidium</i> oocysts in the total volume of the AQUATIC VENUE from an assumed 100 million ( $10^8$ ) oocysts to a maximum concentration of 1 infective oocyst/100 ml by means of consecutive dilution.	
Installation	4.7.3.3.2.3	The SECONDARY DISINFECTION SYSTEM shall be located in the treatment loop (post filtration) and treat a portion (up to 100%) of the recirculation flow prior to return of the water to the POOL or AQUATIC FEATURE.	
Manufacturer's Instructions	4.7.3.3.2.4	The SECONDARY DISINFECTION SYSTEM shall be installed according the manufacturer's directions.	
Minimum Flow Rate Calculation	4.7.3.3.2.5	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 reducing the	

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Keyword	Section	Code	Grade
		number of theoretical infective <i>Cryptosporidium</i> oocysts from an initial total number of 100 million ( $10^8$ ) oocysts to a concentration of 1oocyst/100 ml.	
Equation	4.7.3.3.2.6	Accounting for a 3 log (99.9%) reduction of infective <i>Cryptosporidium</i> oocyst through the SECONDARY DISINFECTION SYSTEM with each pass, the SECONDARY DISINFECTION SYSTEM flow rate (Q) shall be:  $Q = V \times (14.8 - \ln(V) / (60 \times T)), \text{ where:}$ <ul style="list-style-type: none"> <li>• Q = SECONDARY DISINFECTION SYSTEM flow rate (gpm)</li> <li>• V = Total water volume of the aquatic venue or aquatic feature, including surge tanks, piping, equipment, etc. (gals)</li> <li>• T = Dilution time (hrs)</li> </ul>	
Time for Dilution Reduction	4.7.3.3.2.7	The dilution time shall be the lesser of 9 hours or 75% of the uninterrupted time a venue is closed in a 24 hour period.	
Flow Rate Measurements	4.7.3.3.2.8	The SECONDARY DISINFECTION SYSTEM shall include a means to confirm the required flow rate to maintain a minimum 3 log (99.9%) reduction of infective <i>Cryptosporidium</i> oocyst and the minimum flow rate as prescribed above.	
UV Systems	<b>4.7.3.3.3</b>	<b>Ultraviolet Light Systems</b>	
Third Party Validation	4.7.3.3.3.1	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.	
Validation standard	4.7.3.3.3.1.1	The manual US EPA Ultraviolet Disinfectant Guidance Manual shall be considered a recognized national standard in this CODE.	

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Keyword	Section	Code	Grade
<i>Suitable for Intended Use</i>	4.7.3.3.3.2	UV Systems and all materials used therein shall be suitable for their intended use and be installed: <ol style="list-style-type: none"> <li>1) in accordance with this CODE,</li> <li>2) as certified by an ANSI-Accredited third-party testing and certification organization, and</li> <li>3) as specified by the manufacturer.</li> </ol>	
<i>Installation</i>	4.7.3.3.3.3	The UV equipment shall be installed after the filtration and before addition of primary disinfectant.	
<i>Labeled</i>	4.7.3.3.3.3.1	UV equipment shall be labeled with maximum flow rate, minimum transmissivity, minimum intensity, minimum dosage, and maximum gallons of water disinfected by the unit.	
<i>Strainer Installation</i>	4.7.3.3.3.3.2	A simple strainer shall be fitted downstream of the UV system to prevent any glass returning to the POOL in the event of accidental breakage of the quartz sleeve.	
<i>Comply with all Codes</i>	4.7.3.3.3.4	The UV equipment, electrical components, wiring and installation shall comply with all CODES in force where the unit is to be installed.	
<i>Meet UL Standard</i>	4.7.3.3.3.5	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.	
<i>Operation</i>	4.7.3.3.3.5.1	UV systems shall not operate if the recirculation system is not operating.	
<i>Calibrated UV Sensors</i>	4.7.3.3.3.6	The UV equipment shall be complete with calibrated UV sensors, which record the output of all the UV lamps installed in a system.	
<i>Multiple Lamps</i>	4.7.3.3.3.6.1	Where multiple lamps are fitted, sufficient sensors shall be provided to measure each	

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Keyword	Section	Code lamp.	Grade
<i>Fewer Sensors</i>	4.7.3.3.3.6.2	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.	
<i>Equipment Audit</i>	4.7.3.3.3.7	In order to ensure that equipment supplied meets all the requirements of the standard the manufacturer shall maintain a quality assurance system audited on a regular basis to a recognized quality standard.	
<i>Accreditation</i>	4.7.3.3.3.7.1	An ISO9000:2000 accreditation or listings of NSF Standard 50 are both acceptable methods of meeting this equipment requirement.	
<i>Automated Shut Down</i>	4.7.3.3.3.8	The automated shut down of the UV equipment for any reason shall initiate a visual alarm which can be seen by patrons and staff within the facility.	
<i>Signange</i>	4.7.3.3.3.8.1	Signage instructing staff or patrons to notify facility management shall be posted adjacent to the visual alarm. If the facility is not staffed, the sign shall include a means to contact management whenever the facility is in use.	
<i>Reports and Documentation</i>	4.7.3.3.3.9	The UV equipment shall be supplied with the appropriate validation reports and documentation for that equipment model.	
<i>Manufacturer 3-log Inactivation Chart</i>	4.7.3.3.3.10	This documentation will include a graph or chart indicating the dose at which a 3-log inactivation is guaranteed for the system in question.	
<i>RED Bias</i>	4.7.3.3.3.10.1	This dose shall be inclusive of validation factors and REDUCTION EQUIVALENT DOSE (RED) BIAS.	
<i>System Performance Curves</i>	4.7.3.3.3.10.2	System performance curves that do not include such factors are not considered validated	

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Keyword	Section	Code systems.	Grade
Minimum RED	4.7.3.3.3.11	Validation records shall include the graph indicating the minimum intensity reading required at the operational flow for the minimum RED required to achieve 3-log reduction.	
Minimum Intensity Shown	4.7.3.3.3.11.1	Where systems are validated to a specific dose, the graph shall show the minimum intensity reading required at the operational flow for that dose.	
Alternative Validation Protocols	<b>4.7.3.3.3.12</b>	<b>Alternative Validation Protocols</b>	
Recommended Validation Protocol	4.7.3.3.3.12.1	Based on the recommended validation protocol presented in the US EPA Disinfection Guidance Manual, UV reactors certified by ÖNORM and DVGW for a <i>Bacillus subtilis</i> RED of 40mJ/cm <sup>2</sup> shall be granted 3-log <i>Cryptosporidium</i> and 3-log <i>Giardia</i> inactivation credit as required in this CODE.	
Ozone	<b>4.7.3.3.4</b>	<b>Ozone</b>	
3-log Inactivation	4.7.3.3.4.1	SECONDARY DISINFECTION SYSTEMS using ozone shall provide the required inactivation of <i>Cryptosporidium parvum</i> in the full flow of the SECONDARY DISINFECTION SYSTEM after any side-stream has remixed into the full flow of the SECONDARY DISINFECTION SYSTEM.	
Third Party Validation	4.7.3.3.4.2	Ozone systems must be validated by an ANSI-accredited third party testing and certification organization to confirm that they provide a minimum 3 log (99.9%) inactivation of <i>Cryptosporidium parvum</i> 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 POOL or AQUATIC FEATURE recirculation treatment loop.	
Suitable for Use	4.7.3.3.4.3	Ozone systems and all materials used therein	

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Keyword	Section	Code	Grade
		shall be suitable for their intended use, and shall be installed:	
		<ol style="list-style-type: none"> <li>1) in accordance with all applicable requirements,</li> <li>2) as certified by an ANSI-Accredited third-party testing and certification organization, and</li> <li>3) as specified by the manufacturer.</li> </ol>	
<i>Ozone System Components</i>	4.7.3.3.4.4	An ozone system shall be a complete system consisting of the following (either skid-mounted or components):	
		<ol style="list-style-type: none"> <li>1) Ozone generator</li> <li>2) Injector / injector manifold</li> <li>3) Reaction tank (contact tank) / mixing tank / degas tower</li> <li>4) Degas valve (if applicable, to vent un-dissolved gaseous ozone)</li> <li>5) Ozone destruct (to destroy un-dissolved gaseous ozone)</li> <li>6) ORP monitor / controller</li> <li>7) Ambient ozone monitor / controller</li> <li>8) Air flow meter / controller</li> <li>9) Water backflow prevention device in gas delivery system.</li> </ol>	
<i>Appropriate Installation</i>	4.7.3.3.4.5	These components (or skid) shall be installed as specified by the manufacture to maintain the required system validation as noted above.	
<i>ORP Monitor</i>	4.7.3.3.4.6	The ozone generating equipment shall be designed, sized, and controlled utilizing an ORP (OXIDATION reduction potential) monitor / controller (independent of and in addition to any halogen ORP monitor/controller).	
<i>Placed Downstream</i>	4.7.3.3.4.6.1	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.	
<i>Minimum ORP Reading</i>	4.7.3.3.4.6.2	The minimum ORP reading shall be no less	

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		than 600 mV measured directly after (1 to 5 feet) the ozone side-stream remixes into the full flow of the recirculation system.	
<i>Maximum ORP Reading</i>	4.7.3.3.4.6.3	The maximum ORP reading shall be no greater than 900 mV.	
<i>Installation</i>	4.7.3.3.4.7	The ozone system shall be installed after the filtration and before primary disinfectant dosing.	
<i>Ozone Under Pressure</i>	4.7.3.3.4.7.1	For generators that produce ozone under pressure and utilize a negative pressure (Venturi) ozone delivery system, or introduce ozone under pressure (such as a pressurized diffuser into an atmospheric holding tank), any leak or break in the system will immediately cause the release of ozone gas.	
<i>Gas Monitor/Controller</i>	4.7.3.3.4.7.2	An ambient ozone gas monitor/controller shall be utilized to disable the ozone system in the event of an ozone gas leak.	
<i>Comply with Uniform Fire Code</i>	4.7.3.3.4.8	Ozone system installations shall comply with Annex G of the Uniform Fire Code or Section 3705 of the International Fire Code and any other CODES, standards or requirements as mandated by the AHJ.	
<i>Injection Point</i>	4.7.3.3.4.9	The ozone injection point shall be located in the POOL return line after the filtration and heating equipment, prior to the primary disinfectant injection point.	
<i>Injection and Mixing</i>	4.7.3.3.4.9.1	The injection and mixing system shall not prevent the attainment of the recirculation rate required elsewhere in this CODE.	
<i>Air Space Testing</i>	4.7.3.3.4.10	At the time the ozone generating equipment is installed, again after 24 hours of operation and annually thereafter, the air space within 6 (six) inches of the POOL water shall be tested to determine compliance of less than 0.1 PPM (MG/L) gaseous ozone.	

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Results	4.7.3.3.4.10.1	Results of the test shall be maintained on site for review by the local enforcing agency.	
Automatic Shut Down	4.7.3.3.4.11	Automatic shut down shall occur under any condition that would result in the ozone system not operating within the established parameters needed to achieve 3-log inactivation of <i>Cryptosporidium</i> (i.e. low feed gas supply, loss of vacuum or pressure, high dew point in feed air, water in ozone gas delivery line).	
Electrically Interlocked	4.7.3.3.4.11.1	The equipment shall be electrically interlocked with feature pump(s) or automated feature supply valves, such that when the ozone equipment fails to produce the required dosage as measured by ORP, the water features do not operate.	
ORP Reading Audible and Visual Alarm	4.7.3.3.4.12	If the ORP reading for the ozone system drops below 600 mV (regardless of the cause) an audible and visual alarm which can be seen and heard by facility staff and patrons within the facility shall be immediately initiated.	
Signage	4.7.3.3.4.12.1	Signage to notify facility management shall be present adjacent to the visual alarm.	
Regular Audits	4.7.3.3.4.13	In order to ensure that ozone system supplied meets all the requirements of the standard the manufacturer shall maintain a quality system audited on a regular basis to a recognized quality standard.	
Acceptable methods	4.7.3.3.4.13.1	Acceptable methods of meeting this equipment requirement include: <ol style="list-style-type: none"> <li>1) ISO9000:2000 accreditation, or</li> <li>2) listing to NSF Standard 50, or</li> <li>3) both.</li> </ol>	
Reports and Documentation	4.7.3.3.4.14	The ozone system shall be supplied with the	

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Keyword	Section	Code	Grade
		appropriate validation reports and documentation for that equipment model.	
3-log Inactivation Chart	4.7.3.3.4.14.1	This will include a graph or chart or other documentation which clearly indicates the required operating parameters for which a 3-log inactivation is guaranteed for the system in question.	
Inclusive	4.7.3.3.4.14.2	This dose shall be inclusive of validation factors.	
System Performance Curves	4.7.3.3.4.14.3	System performance curves that do not include such factors are not considered validated systems.	
Validation	<b>4.7.3.3.4.15</b>	<b>Validation</b>	
Acceptable Validations	4.7.3.3.4.15.1	There currently is no recognized national standard for validation of ozone equipment for inactivation of cryptosporidium.	
Supplemental Treatment Systems	<b>4.7.3.4</b>	<b>Supplemental Treatment Systems</b>	
General	<b>4.7.3.4.1</b>	<b>General Requirements</b>	
Optional	4.7.3.4.1.1	AQUATIC VENUES that do not require SECONDARY DISINFECTION SYSTEMS may install SUPPLEMENTAL TREATMENT SYSTEMS for the purpose of enhancing overall system performance and improving water quality.	
Not Required	4.7.3.4.1.2	SUPPLEMENTAL TREATMENT SYSTEMS are not required on any venues.	
Does not meet Secondary Disinfection System Requirements	4.7.3.4.1.3	It shall be clearly noted in the facility operating instructions that these SUPPLEMENTAL TREATMENT SYSTEMS do not meet the requirements of a SECONDARY DISINFECTION SYSTEM, and as such, are only considered SUPPLEMENTAL TREATMENT SYSTEMS.	
No 3-log Inactivation	4.7.3.4.1.4	SUPPLEMENTAL TREATMENT SYSTEMS shall meet	

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Keyword Required	Section	Code	Grade
		all of the requirements of this CODE, except:	
		<ol style="list-style-type: none"> <li>1) They do not need to achieve a 3-log (99.9%) inactivation of <i>Cryptosporidium parvum</i> as required in Section 4.7.3.3,</li> <li>2) They do not need to be able to reduce the total number of infective oocysts to 1 oocyst per 100 ml as required in Section 4.7.3.3, and</li> <li>3) Except as noted in Sections 4.7.3.4.2 and 4.7.3.4.3 below.</li> </ol>	
Clearly Labeled	4.7.3.4.1.5	Each system shall be clearly labeled: "Supplemental Water Treatment System—Not to be Used for Disinfection."	
UV Light	<b>4.7.3.4.2</b>	<b>Ultraviolet Light</b>	
UV as Supplemental Treatment Requirement	4.7.3.4.2.1	When UV is used as a SUPPLEMENTAL TREATMENT SYSTEM, all requirements of 4.7.3.3.3.2 thru 4.7.3.3.3.4 must be met.	
Not Required	4.7.3.4.2.2	When UV is used as a SUPPLEMENTAL TREATMENT SYSTEM, all other sections of 4.7.3.3.3 are not required.	
Water Features	4.7.3.4.2.3	Water features do not need to be shut off if the UV system does not produce the required dosage.	
Exempt	4.7.3.4.2.4	The equipment is exempt from the validation requirements of Section 4.7.3.3.3.1.1.	
Ozone	<b>4.7.3.4.3</b>	<b>Ozone</b>	
Ozone as Supplemental Treatment Requirement	4.7.3.4.3.1	When ozone is used as a SUPPLEMENTAL TREATMENT SYSTEM all requirements of 4.7.3.3.4.3 thru 4.7.3.3.4.10 must be met.	
Not Required	4.7.3.4.3.2	All other sections of 4.7.3.3.4 are not required.	
Copper/Silver Ion	<b>4.7.3.4.4</b>	<b>Copper / Silver Ion</b>	
Only EPA-Registered	4.7.3.4.4.1	Only those systems that are EPA-REGISTERED	

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<i>Disinfectants</i>		for use as disinfectants in POOLS or spas in the United States shall be permitted.	
<i>Suitable</i>	4.7.3.4.4.2	Copper/silver systems, and all materials used therein, shall be suitable for their intended use.	
<i>Installed</i>	4.7.3.4.4.3	Copper/silver systems, and all materials used therein, shall be installed in accordance with all applicable requirements and manufacturers instructions	
<i>UV/Peroxide Systems</i>	<b>4.7.3.4.5</b>	<b><i>Ultraviolet Light / Hydrogen Peroxide Systems</i></b>	
<i>Prohibited</i>	4.7.3.4.5.1	Ultraviolet Light / Hydrogen Peroxide systems shall be prohibited.	

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## Model Aquatic Health Code Disinfection & Water Quality Code 5.0 Operation and Maintenance

Keyword	Section	Code	Grade
	<b>5.0</b>	<b>Operation and Maintenance</b>	
	<b>5.1</b>	<b>Plan Submittal</b>	
	<b>5.2</b>	<b>Materials</b>	
	<b>5.3</b>	<b>Equipment Standards</b>	
	<b>5.4</b>	<b>Pool Operation and Facility Maintenance</b>	
	<b>5.5</b>	<b>Pool Structure</b>	
	<b>5.6</b>	<b>Indoor/Outdoor Environment</b>	
	<b>5.7</b>	<b>Recirculation and Water Treatment</b>	
	<b>5.7.1</b>	<b>Recirculation Systems and Equipment</b>	
	<b>5.7.2</b>	<b>Filtration</b>	
	<b>5.7.3</b>	<b>Disinfection</b>	
<i>Primary Disinfectants</i>	<b>5.7.3.1</b>	<b>Primary Disinfectants</b>	
<i>Acceptable</i>		Only the primary disinfectants outlined in section 5.7.3.1 of this code are acceptable for use in AQUATIC VENUES.	
<i>Chlorine</i>	<b>5.7.3.1.1</b>	<b>Chlorine</b>	
<i>EPA Registered</i>	5.7.3.1.1.1	Only CHLORINE products that are EPA-REGISTERED for use as disinfectants in POOLS or spas in the United States are permitted.	
<i>Minimum Free FAC Concentrations</i>	5.7.3.1.1.2	Minimum FAC concentrations shall be maintained at all times in all areas as follows:	
<i>Not using Cyanuric Acid</i>		1. Swimming POOLS and all other AQUATIC VENUES <b>not</b> using cyanuric acid: 1.0 PPM (MG/L)	A
<i>Using Cyanuric Acid</i>		2. Swimming POOLS and all other AQUATIC VENUES using cyanuric acid: 2.0 PPM (MG/L)	B
<i>Spas</i>		3. Spas: 3.0 PPM (MG/L)	
<i>Bromine</i>	<b>5.7.3.1.2</b>	<b>Bromine</b>	B

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Keyword	Section	Code	Grade
EPA Registered	5.7.3.1.2.1	Only bromine products that are EPA-REGISTERED for use as disinfectants in POOLS or spas in the United States are permitted. Bromine-based disinfectants may be applied to POOLS and spas through the addition of an organic bromine compound (1,3-Dibromo-5,5-dimethylhydantoin (DBDMH) or 1-bromo-3-chloro-5,5-dimethylhydantoin (BCDMH)).	
Minimum Bromine Concentrations	5.7.3.1.2.2	Minimum bromine concentrations shall be maintained at all times in all areas as follows: <ol style="list-style-type: none"> <li>1) Swimming POOLS and all other AQUATIC VENUES: 3.0 PPM (MG/L)</li> <li>2) Spas: 6.0 PPM (MG/L)</li> </ol>	
Use with Ozone and Cyanuric Acid	5.7.3.1.2.3	Bromine shall not be used with ozone or cyanuric acid.	
Stabilizers	<b>5.7.3.2</b>	<b>Stabilizers</b>	
Cyanuric Acid	<b>5.7.3.2.1</b>	<b>Cyanuric Acid (CYA)</b>	B
Not Used in specific Aquatic Venues	5.7.3.2.1.1	<i>Cyanuric acid or stabilized CHLORINE products shall <b>not</b> be used at the following for all new construction, modifications, or DISINFECTION equipment replacements after the effective date of this CODE:</i> <ol style="list-style-type: none"> <li>1) <i>All increased risk venues requiring secondary DISINFECTION as per Section 4.7.3.3.1.2 of this CODE;</i></li> <li>2) <i>All spas; and</i></li> <li>3) <i>All indoor venues.</i></li> </ol>	
Outdoor Aquatic Venues	<b>5.7.3.2.1.2</b>	<b>Outdoor Aquatic Venues</b>	
CYA Level	5.7.3.2.1.2.1	The cyanuric acid level at outdoor AQUATIC VENUES shall remain below 50 PPM (MG/L).	
Secondary Disinfection	<b>5.7.3.3</b>	<b>Secondary Disinfection Systems</b>	
Ultraviolet Light	<b>5.7.3.3.1</b>	<b>Ultraviolet Light</b>	A

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Operate with Recirculation System	5.7.3.3.1.1	UV systems shall only operate while the recirculation system is operating.	
3-log Inactivation	5.7.3.3.1.2	UV systems shall be operated and maintained not to exceed the maximum validated flow rate and meet no less than the minimum validated output intensity.	
Free Available Chlorine and Bromine Levels	5.7.3.3.1.3	Use of UV does not modify any other water quality requirements.	
Calibrated Sensors	5.7.3.3.1.4	UV sensors shall be calibrated at a frequency in accordance with manufacturer recommendations.	
Records	5.7.3.3.1.5	Records of calibration shall be maintained by the facility.	
Record and Store Data	5.7.3.3.1.6	The equipment shall be capable of recording and storing operational data within internal memory in order to meet record keeping requirements as defined elsewhere in this CODE.	
Ozone	<b>5.7.3.3.2</b>	<b>Ozone</b>	A
3-log Inactivation	5.7.3.3.2.1	Ozone systems shall be operated and maintained according to the manufacturer's instructions to maintain the required design performance.	
Residual Ozone Concentration	5.7.3.3.2.2	Residual ozone concentration in the POOL water shall remain below 0.1 PPM (MG/L).	
Free Available Chlorine and Bromine Levels	5.7.3.3.2.3	Use of ozone does not modify any other water quality requirements.	
Standard Operating Manual	5.7.3.3.2.4	A printed standard operating manual shall be provided containing information on the operation and maintenance of the ozone generating equipment, including the responsibilities of workers in an emergency.	
Employees Trained	5.7.3.3.2.5	All employees shall be properly trained in the operation and maintenance of the equipment.	

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Keyword	Section	Code	Grade
Supplemental Treatment	<b>5.7.3.4</b>	<b>Supplemental Treatment Systems</b>	
UV Light	<b>5.7.3.4.1</b>	<b>UV Light</b>	A
Free Available Chlorine and Bromine Levels	5.7.3.4.1.1	Use of UV does not modify any other water quality requirements.	
Ozone	<b>5.7.3.4.2</b>	<b>Ozone</b>	A
Residual Ozone Concentration	5.7.3.4.2.1	Residual ozone concentration in the POOL water shall remain below 0.1 PPM (MG/L).	
Free Available Chlorine and Bromine Levels	5.7.3.4.2.2	Use of ozone does not modify any other water quality requirements.	
Copper/Silver Ions	<b>5.7.3.4.3</b>	<b>Copper / Silver Ions</b>	A
EPA Registered	5.7.3.4.3.1	Only those systems that are EPA-REGISTERED for use as disinfectants in POOLS or spas in the United States are permitted.	
Concentrations	5.7.3.4.3.2	Copper and silver concentrations shall not exceed established EPA limits for use as disinfectants in pools and spas in the United States.	
Free Available Chlorine and Bromine Levels	5.7.3.4.3.3	FREE AVAILABLE CHLORINE or bromine levels shall be maintained in accordance with Section 5.7.3.1.1 or 5.7.3.1.2, respectively.	
pH	<b>5.7.3.5</b>	<b>pH</b>	
pH levels	5.7.3.5.1	The pH of the water shall be maintained between 7.2 and 7.8.	B
Water Quality	<b>5.7.4</b>	<b>Water Quality</b>	
	<b>5.7.4.1</b>	<b>Sample Collection and Analysis</b>	
	<b>5.7.4.2</b>	<b>Microbiological Quality</b>	
	<b>5.7.4.3</b>	<b>Chemical Quality</b>	
	<b>5.7.4.3.1</b>	<b>Physiological Effects to Bathers</b>	
Total Alkalinity Levels	<b>5.7.4.3.2</b>	<b>Total Alkalinity Levels</b>	C
Range	5.7.4.3.2.1	Total alkalinity shall be maintained in the range of	

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Keyword	Section	Code	Grade
		80 to 150 PPM (MG/L).	
<i>Water Chemical Balance</i>	<b>5.7.4.3.3</b>	<b><i>Pool Water Chemical Balance</i></b>	
<i>Chloramines (Combined Chlorine)</i>	5.7.4.3.3.1	Chloramines in water shall remain below 0.4 PPM (MG/L).	B
<i>PHMB</i>	5.7.4.3.3.2	Polyhexamethylene biguanide (PHMB) shall be prohibited for use as a disinfectant.	A
<i>Chlorine Dioxide</i>	5.7.4.3.3.3	CHLORINE dioxide shall be prohibited for use as a primary disinfectant while bathers are present in the water.	A
<i>Chlorine Dioxide</i>	5.7.4.3.3.3.1	CHLORINE dioxide may be used to disinfect aquatic venues while bathers are not in the water.	
<i>Hydrogen Peroxide</i>	5.7.4.3.3.4	Hydrogen peroxide shall be prohibited for use as a disinfectant.	A
<i>Algaecides</i>	5.7.4.3.3.5	Algaecides may be used in an AQUATIC VENUE provided: <ol style="list-style-type: none"> <li>1) The product is labeled as an algaecide for POOL or spa use.</li> <li>2) The product is used in strict compliance with label instructions.</li> <li>3) The product is registered with the US EPA and applicable state agency.</li> </ol>	A
<i>Calcium Hardness</i>	5.7.4.3.3.6	Calcium hardness shall not exceed 400 PPM (MG/L).	C
<i>Langlier Saturation Index</i>	5.7.4.3.3.7	The exact level is dependent on the PH and temperature of the POOL water, and can be calculated using the Langelier Saturation Index.	
<i>Total Dissolved Solids</i>	<b>5.7.4.3.4</b>	<b><i>Total Dissolved Solids (TDS)</i></b>	C
<i>Maximum Level</i>	5.7.4.3.4.1	The maximum acceptable level of TDS for swimming POOLS shall be 1,500 PPM (MG/L) above the TDS level in the fill water.	

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Keyword	Section	Code	Grade
Saltwater Pools	5.7.4.3.4.2	For saltwater POOLS, startup TDS level shall be measured on the initial fill after adding the salt for the CHLORINE generator.	
Source Water	<b>5.7.4.3.5</b>	<b>Source (fill) Water</b>	
Owner Responsibilities	5.7.4.3.5.1	The owner of a public swimming POOL, public spa, or special use POOL shall ensure that the water supply for the facility meets one of the following requirements: <ol style="list-style-type: none"> <li>1) The water comes from a public water system as defined by the applicable rules of the AHJ in which the facility is located; or</li> <li>2) The water is treated to meet the requirements cited in the preceding paragraph (1).</li> </ol>	
Water Balance/ Saturation Index	<b>5.7.4.4</b>	<b>Water Balance/Saturation Index</b>	B
Range	5.7.4.4.1	Water balance shall fall within the range of -0.5 to +0.5, as determined by the Langelier Saturation Index.	
Water Clarity	<b>5.7.4.5</b>	<b>Water Clarity</b>	
Temperature	<b>5.7.4.6</b>	<b>Temperature</b>	B
Maximum	5.7.4.6.1	Water temperature shall comply with the following <b>maximum</b> values: <ol style="list-style-type: none"> <li>1) Warm water (spas) or INCREASED RISK AQUATIC VENUES (therapy POOLS): 104° F</li> </ol>	