

Model Aquatic Health Code

Draft Disinfection and Water Quality Module CODE Section Modified after the First 60-day Review that Closed on 4/27/2012

Informational Copy: NOT Currently Open for Public Comment

This version of the MAHC Disinfection and Water Quality Module has been modified based on the first round of public comments received. It is being re-posted so users can view how it was modified but is not currently open to public comment. 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 public comments and MAHC responses can be viewed on the web at <http://www.cdc.gov/healthywater/swimming/pools/mahc/structure-content/index.html>

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 some “increased risk” aquatic venues

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>).

MAHC Strawman

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

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- 4.4 Aquatic Facility Operation and Maintenance [N/A]
- 4.5 Aquatic Venue Structure (Shell)
- 4.6 Indoor/Outdoor Environment
- 4.7 Recirculation and Water Treatment

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AHJ	authority having jurisdiction
ANSI	American National Standards Institute
BCDMH	1-bromo-3-chloro-5, 5-dimethylhydantoin
CYA	Cyanuric acid
DBDMH	dibromodimethylhydantoin
DMH	dimethyl hydantoin
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
IARC	International Agency for Research on Cancer
NSF	National Sanitation Foundation
ÖNORM	Österreichisches Normungsinstitut (Austrian Standards Institute)
ORP	oxidation reduction potential
PPM	parts per million
RED	Reduction Equivalent Dose

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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.

“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.

“Bather Load” means the maximum number of persons allowed in the water of an AQUATIC VENUE. Bather load is used to determine the number of RINSE and CLEANSING SHOWERS. Bather Load is not the same as OCCUPANT LOAD which refers to maximum aquatic facility loads.

“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 aquatic venues.

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

“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.

“Disinfection By-Product” means a chemical compound formed by the reaction of a disinfectant (e.g. CHLORINE) with a precursor (e.g. natural organic matter, nitrogenous waste from bathers) in a water system (pool, water supply).

“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⁻) plus hydrogen ion (H⁺)), 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⁻ 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⁻ 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.

“Hot Water” means an AQUATIC VENUE with a temperature over 90 degrees Fahrenheit (30 degrees Celsius).

“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.

“Interactive Water Aquatic Venue” means any indoor or outdoor installation with no standing water that includes water sprays, dancing water jets, waterfalls, dumping buckets, or shooting water cannons in various arrays for the purpose of wetting the persons playing in the spray streams.

“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 removed from the water or to become more soluble in the water. It is the “chemical cleaning” of pool water. Oxidation can be achieved by chlorine, bromine, ozone, and 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 correction that accounts for the difference between the UV dose measured with a surrogate microorganism and the UV dose that would be delivered to a target pathogen due to differences in the microorganisms inactivation kinetics.

“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.

“Spray Pad” means no standing water exists in the aquatic venue. It includes features that spray bathers with recirculating water.

“Substantial Alteration” means the alteration, modification, or renovation of an aquatic venue where the total cost of the work exceeds 50% of the replacement cost of the aquatic venue.

“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.

“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.

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.

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

Keyword	Section	Code	Grade
	4.0	Design and Construction	
	4.1	Plan Submittal	
	4.2	Materials	
	4.3	Equipment Standards	
	4.4	Aquatic Facility Operation and Facility Maintenance	
	4.5	Aquatic Venue 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	
<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 approved by the AHJ.	
<i>Required Facilities</i>	4.7.3.3.1.2	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: <ol style="list-style-type: none"> 1) AQUATIC VENUES designed primarily for diaper-aged children (children <5 years old), such as 	

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		<ul style="list-style-type: none"> a. wading AQUATIC VENUES, b. INTERACTIVE WATER AQUATIC VENUE with no standing water, c. SPRAY PADS, and 2) Therapy pools.	
Other Aquatic Venues	4.7.3.3.1.3	Optional SECONDARY DISINFECTION SYSTEMS may be installed on other AQUATIC VENUES not specified in MAHC Section 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 MAHC Section 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 MAHC Section 4.7.3.4.	
Oocyst Reduction	4.7.3.3.2	3-log Inactivation and Oocyst Reduction	
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.	
Installation	4.7.3.3.2.2	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 AQUATIC VENUE OR AQUATIC FEATURE.	
Manufacturer's Instructions	4.7.3.3.2.3	The SECONDARY DISINFECTION SYSTEM shall be installed according the manufacturer's directions.	
Minimum Flow Rate Calculation	4.7.3.3.2.4	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 number of assumed infective	

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		<i>Cryptosporidium</i> OOCYSTS from an initial total number of 100 million (10 ⁸) OOCYSTS to a concentration of 1 OOCYST/100 ml.	
Equation	4.7.3.3.2.5	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 x ((14.8 – ln (V))) / (60 x T)), where: <ul style="list-style-type: none"> • 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) • T = Dilution time (hrs.) 	
Time for Dilution Reduction	4.7.3.3.2.6	The dilution time shall be the lesser of 9 hours or 75% of the uninterrupted time an aquatic venue is closed in a 24 hour period.	
Flow Rate Measurements	4.7.3.3.2.7	Where a SECONDARY DISINFECTION SYSTEM is installed, a means to confirm the required flow rate to maintain a minimum 3 log (99.9%) reduction of infective <i>Cryptosporidium</i> OOCYST at the minimum flow rate as prescribed above.	
Flow Rate Defined	4.7.3.3.2.7.1	The flow rate shall be as defined in MAHC Section 4.7.3.3.2.6.	
UV Systems	4.7.3.3.3	Ultraviolet Light Systems	
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 US EPA Ultraviolet Disinfectant Guidance Manual shall be considered a recognized national standard in this CODE.	

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"> 1) in accordance with this CODE, 2) as certified by an ANSI-Accredited third-party testing and certification organization, and 3) as specified by the manufacturer. 	
<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 the following design specifications: 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 AQUATIC VENUE 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>Electronically Interlocked</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.	

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Keyword	Section	Code	Grade
<i>Multiple Lamps</i>	4.7.3.3.3.6.1	Where multiple lamps are fitted, sufficient sensors shall be provided to measure each lamp.	
<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 or other indication which will alert staff on site or remotely.	
<i>Signage</i>	4.7.3.3.3.8.1	Signage instructing staff or patrons to notify facility management shall be posted adjacent to the visual indication.	
<i>Not Staffed</i>	4.7.3.3.3.8.2	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	

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		validated systems.	
<i>Minimum RED</i>	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.	
<i>Minimum Intensity Shown</i>	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.	
<i>Recommended Validation Protocol</i>	4.7.3.3.3.12.	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 ² shall be granted 3-log <i>Cryptosporidium</i> and 3-log <i>Giardia</i> inactivation credit as required in this CODE.	
<i>Ozone Disinfection</i>	4.7.3.3.4	Ozone Disinfection	
<i>3-log Inactivation</i>	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.	
<i>Third Party Validation</i>	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 AQUATIC VENUE or AQUATIC FEATURE recirculation treatment loop.	
<i>Suitable for Use</i>	4.7.3.3.4.3	Ozone systems and all materials used therein shall be suitable for their intended use, and shall be installed:	

Keyword	Section	Code	Grade
Ozone System Components	4.7.3.3.4.4	<ol style="list-style-type: none"> 1) in accordance with all applicable requirements, 2) as certified by an ANSI-Accredited third-party testing and certification organization, and 3) as specified by the manufacturer. <p>An ozone system shall be a complete system consisting of the following (either skid-mounted or components):</p> <ol style="list-style-type: none"> 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 9) Water backflow prevention device in gas delivery system. 	
Appropriate Installation	4.7.3.3.4.5	<p>These components (or skid) shall be installed as specified by the manufacture to maintain the required system validation as noted above.</p>	
ORP Monitor	4.7.3.3.4.6	<p>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).</p>	
Placed Downstream	4.7.3.3.4.6.1	<p>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.</p>	
Minimum ORP Reading	4.7.3.3.4.6.2	<p>The minimum ORP reading shall be no less than 600 mV measured directly after (1 to 5 feet) the ozone side-stream remixes into the full flow of the recirculation system.</p>	

Keyword	Section	Code	Grade
Maximum ORP Reading	4.7.3.3.4.6.3	The maximum ORP reading shall be no greater than 900 mV.	
Installation and Injection Point	4.7.3.3.4.7	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.	
Injection and Mixing	4.7.3.3.4.7.1	The injection and mixing system shall not prevent the attainment of the recirculation rate required elsewhere in this CODE.	
Gas Monitor/ Controller	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.	
Comply with Uniform Fire Code	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.	
Air Space Testing	4.7.3.3.4.9	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 AQUATIC VENUE water shall be tested to determine compliance of less than 0.1 PPM (MG/L) gaseous ozone.	
Results	4.7.3.3.4.9.1	Results of the test shall be maintained on site for review by the local enforcing agency.	
Automatic Shut Down	4.7.3.3.4.10	Automatic shutdown 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	4.7.3.3.4.10.1	The equipment shall be electrically interlocked with feature pump(s) or automated feature supply valves, such that when the ozone equipment fails to produce	

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Keyword	Section	Code	Grade
		the required dosage as measured by ORP, the water features do not operate.	
ORP Reading Visual Indication	4.7.3.3.4.11	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.	
Signage	4.7.3.3.4.11.1	Signage to notify facility management shall be present adjacent to the visual alarm.	
Regular Audits	4.7.3.3.4.12	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.	
Listed	4.7.3.3.4.12.1	Ozone equipment shall be listed to NSF Standard 50.I.	
Reports and Documentation	4.7.3.3.4.13	The ozone system shall be supplied with the appropriate validation reports and documentation for that equipment model.	
3-log Inactivation Chart	4.7.3.3.4.13.1	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	4.7.3.3.4.13.2	This dose shall be inclusive of validation factors.	
System Performance Curves	4.7.3.3.4.13.3	System performance curves that do not include such factors are not considered validated systems.	
Supplemental Treatment Systems	4.7.3.4	Supplemental Treatment Systems	
General	4.7.3.4.1	General Requirements	

Keyword	Section	Code	Grade
<i>Optional</i>	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.	
<i>Not Required</i>	4.7.3.4.1.2	SUPPLEMENTAL TREATMENT SYSTEMS shall not be required on any venues.	
<i>Does not meet Secondary Disinfection System Requirements</i>	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.	
<i>No 3-log Inactivation Required</i>	4.7.3.4.1.4	<p>SUPPLEMENTAL TREATMENT SYSTEMS shall meet all of the requirements of this CODE, except:</p> <ol style="list-style-type: none"> 1) They do not need to achieve a 3-log (99.9%) inactivation of <i>Cryptosporidium parvum</i> as required in MAHC Section 4.7.3.3, 2) They do not need to be able to reduce the total number of infective OOCYSTS to 1OOCYST per 100 ml as required in MAHC Section 4.7.3.3, and 3) Except as noted in MAHC Sections 4.7.3.4.2 and 4.7.3.4.3 below. 	
<i>Clearly Labeled</i>	4.7.3.4.1.5	Each system shall be clearly labeled, "Supplemental Water Treatment System— Does Not meet the requirements for Secondary Disinfection."	
<i>UV Light</i>	4.7.3.4.2	Ultraviolet Light	
<i>UV as Supplemental Treatment Requirement</i>	4.7.3.4.2.1	When UV is used as a SUPPLEMENTAL TREATMENT SYSTEM, all requirements of MAHC Section 4.7.3.3.3.2 thru 4.7.3.3.3.4 shall be met.	
<i>Water Features</i>	4.7.3.4.2.3	Water features do not need to be shut off if the UV system does not produce the	

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Keyword	Section	Code	Grade
		required dosage.	
<i>Exempt</i>	4.7.3.4.2.4	The equipment is exempt from the validation requirements of MAHC Section 4.7.3.3.1.1.	
<i>Ozone</i>	4.7.3.4.3	<i>Ozone</i>	
<i>Ozone as Supplemental Treatment Requirement</i>	4.7.3.4.3.1	When ozone is used as a SUPPLEMENTAL TREATMENT SYSTEM all requirements of MAHC Section 4.7.3.3.4.3 thru 4.7.3.3.4.9 shall be met.	
<i>Copper/Silver Ion Systems</i>	4.7.3.4.4	<i>Copper / Silver Ion Systems</i>	
<i>Only EPA-Registered Disinfectants</i>	4.7.3.4.4.1	Only those systems that are EPA-REGISTERED for use as disinfectants in AQUATIC VENUES 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>	4.7.3.4.5	<i>Ultraviolet Light / Hydrogen Peroxide Systems</i>	
<i>Prohibited</i>	4.7.3.4.5.1	Ultraviolet Light / Hydrogen Peroxide combination systems shall be prohibited.	

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

Keyword	Section	Code	Grade
	5.0	Operation and Maintenance	
	5.1	Plan Submittal	
	5.2	Materials	
	5.3	Equipment Standards	
	5.4	Aquatic Facility Operation and Maintenance	
	5.5	Aquatic Venue Structure	
	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	
<i>Primary Disinfectants</i>	5.7.3.1	<i>Primary Disinfectants</i>	
<i>Acceptable</i>		Only the primary disinfectants outlined in MAHC Section 5.7.3.1 of this code shall be acceptable for use in AQUATIC VENUES.	
<i>Chlorine</i>	5.7.3.1.1	<i>Chlorine (Ca/Na/Li Hypochlorite)</i>	
<i>EPA Registered</i>	5.7.3.1.1.1	Only CHLORINE products that are EPA-REGISTERED for use as sanitizers or disinfectants in AQUATIC VENUES or spas in the United States are permitted.	
<i>Minimum 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. AQUATIC VENUES not using cyanuric acid: 1.0 PPM (MG/L)	A
<i>Using Cyanuric Acid</i>		2. AQUATIC VENUES using cyanuric acid: 2.0 PPM (MG/L)	B
<i>Spas</i>		3. Spas: 3.0 PPM (MG/L)	
<i>Waterslides</i>	5.7.3.1.1.3	Waterslide lines susceptible to holding stagnant water shall maintain disinfectant throughout the lines as per MAHC Section 5.7.3.1.1.2.	
<i>Bromine</i>	5.7.3.1.2	<i>Bromine</i>	B
<i>EPA Registered</i>	5.7.3.1.2.1	Only bromine products that are EPA-REGISTERED	
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Keyword	Section	Code	Grade
		for use as sanitizers or disinfectants in AQUATIC VENUES or spas in the United States are permitted. <i>Note: Bromine-based disinfectants may be applied to AQUATIC VENUES 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)).</i>	
Minimum Bromine Concentrations	5.7.3.1.2.2	Minimum bromine concentrations shall be maintained at all times in all areas as follows: 1) All AQUATIC VENUES: 3.0 PPM (MG/L) 2) Spas: 4.00 PPM (MG/L)	
Stabilizers	5.7.3.2	<i>Stabilizers</i>	
Cyanuric Acid	5.7.3.2.1	<i>Cyanuric Acid (CYA)</i>	B
Not Used in specific Aquatic Venues	5.7.3.2.1.1	Cyanuric acid or stabilized CHLORINE products shall not be used at the following for all new construction, modifications, or DISINFECTION equipment replacements after the effective date of this CODE: 1) Spas; and 2) Therapy pools.	
Replacement Times	5.7.3.2.1.1.1	These aquatic venues shall no longer use cyanuric acid or stabilized CHLORINE products no later than 4 years after adoption of this code.	
Outdoor Aquatic Venues	5.7.3.2.1.2	The cyanuric acid level at outdoor AQUATIC VENUES shall remain at or below 100 PPM (MG/L).	
Secondary Disinfection	5.7.3.3	<i>Secondary Disinfection Systems</i>	
	5.7.3.3.1	<i>General Requirements [N/A]</i>	
	5.7.3.3.2	<i>3-Log Inactivation [N/A]</i>	
Ultraviolet Light	5.7.3.3.3	<i>Ultraviolet Light</i>	A
Operate with Recirculation System	5.7.3.3.3.1	UV systems shall only operate while the recirculation system is operating.	

Keyword	Section	Code	Grade
3-log Inactivation	5.7.3.3.3.2	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 for a 3-log inactivation.	
Free Available Chlorine and Bromine Levels	5.7.3.3.3.3	Use of UV does not modify any other water quality requirements.	
Calibrated Sensors	5.7.3.3.3.4	UV sensors shall be calibrated at a frequency in accordance with manufacturer recommendations.	
Records	5.7.3.3.3.5	Records of calibration shall be maintained by the facility.	
Record and Store Data	5.7.3.3.3.6	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	5.7.3.3.4	Ozone	A
3-log Inactivation	5.7.3.3.4.1	Ozone systems shall be operated and maintained according to the manufacturer's instructions to maintain the required design performance.	
Residual Ozone Concentration	5.7.3.3.4.2	Residual ozone concentration in the AQUATIC VENUE water shall remain below 0.1 PPM (MG/L).	
Free Available Chlorine and Bromine Levels	5.7.3.3.4.3	Use of ozone does not modify any other water quality requirements.	
Standard Operating Manual	5.7.3.3.4.4	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	5.7.3.3.4.5	All employees shall be properly trained in the operation and maintenance of the equipment.	
Supplemental Treatment	5.7.3.4	Supplemental Treatment Systems	
UV Light	5.7.3.4.1	Ultraviolet Light	A
Use of UV	5.7.3.4.1.1	Use of UV does not modify any other water	

Keyword	Section	Code	Grade
		quality requirements.	
Ozone	5.7.3.4.2	Ozone	A
Residual Ozone Concentration	5.7.3.4.2.1	Residual ozone concentration in the AQUATIC VENUE water shall remain below 0.1 PPM (MG/L).	
Ozone Use	5.7.3.4.2.2	Use of ozone does not modify any other water quality requirements.	
Copper/Silver Ions	5.7.3.4.3	Copper / Silver Ions	A
EPA Registered	5.7.3.4.3.1	Only those systems that are EPA-REGISTERED for use as sanitizers or disinfectants in AQUATIC VENUES or spas in the United States are permitted.	
Concentrations	5.7.3.4.3.2	Copper and silver concentrations shall not exceed 1.3 ppm for copper and 0.10 ppm for silver for use as disinfectants in aquatic venues 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 MAHC Section 5.7.3.1.1 or 5.7.3.1.2, respectively.	
Other Sanitizers or Disinfectants	5.7.3.5	Other Sanitizers or Disinfectants	
Other Sanitizers or Disinfectants	5.7.3.5.1	Other sanitizers or disinfectants used must not create a hazardous condition or compromise disinfectant efficacy when used with required bromine or chlorine concentrations. Water quality must still meet all criteria set forth in this code.	
Chlorine Dioxide	5.7.3.5.2	CHLORINE dioxide shall only be used for remediation for water quality issues when the aquatic venue is closed and bathers are not present.	
Safety Considerations	5.7.3.5.2.1	Safety training and safety precautions related to use of chlorine dioxide shall be in place.	
pH	5.7.3.6	pH	
pH levels	5.7.3.6.1	The PH of the water shall be maintained between 7.2 and 7.8.	B

Keyword	Section	Code	Grade
Other Products	5.7.3.7	<i>Other Aquatic Venue Water Treatment Products</i>	
Clarifiers, Flocculants, Defoamers	5.7.3.7.1	Clarifiers, flocculants, and defoamers shall be used per manufacturer's instructions.	
Water Quality	5.7.4	Water Quality	
	5.7.4.1	<i>Sample Collection and Analysis</i>	
	5.7.4.2	<i>Microbiological Quality</i>	
	5.7.4.3	<i>Chemical Quality</i>	
	5.7.4.3.1	<i>Physiological Effects to Bathers</i>	
Total Alkalinity Levels	5.7.4.3.2	<i>Total Alkalinity Levels</i>	C
Range	5.7.4.3.2.1	Total alkalinity shall be maintained in the range of 60 to 180 PPM (MG/L).	
Water Chemical Balance	5.7.4.3.3	<i>Aquatic Venue Water Chemical Balance</i>	
Combined Chlorine (Chloramines)	5.7.4.3.3.1	Combined chlorine (chloramines) in water shall remain below 0.4 PPM (MG/L).	B
Calcium Hardness	5.7.4.3.3.2	Calcium hardness shall not exceed 1000 PPM (MG/L) and maintained per MAHC Section 5.7.4.4.	
Algaecides	5.7.4.3.3.3	Algaecides may be used in an AQUATIC VENUE provided: <ol style="list-style-type: none"> 1) The product is labeled as an algaecide for AQUATIC VENUE or spa use. 2) The product is used in strict compliance with label instructions. 3) The product is registered with the US EPA and applicable state agency. 	A
Source Water	5.7.4.3.4	<i>Source (fill) Water</i>	
Owner Responsibilities	5.7.4.3.4.1	The owner of a public aquatic venue, public spa, or special use AQUATIC VENUE shall ensure that the water supply for the facility meets one of the following requirements: <ol style="list-style-type: none"> 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 	

Keyword	Section	Code	Grade
		<ul style="list-style-type: none"> 2) The water meets the requirements of the local AHJ for public water systems; or 3) The AHJ has approved an alternative water source for use in the aquatic facility. 	
<i>Saturation Index</i>	5.7.4.4	<i>Saturation Index for Aquatic Venues</i>	B
<i>Water Balance Determination</i>	5.7.4.4.1	<p>Water balance can be determined by using the Langelier Saturation Index, Ryznar Stability Index, or other indices that are based on calculated values of:</p> <ul style="list-style-type: none"> 1) total alkalinity, 2) pH, 3) calcium hardness, 4) total dissolved solids, and 5) water temperature. 	
<i>Langelier Saturation Index</i>	5.7.4.4.2	Maintaining individual values in the range allowed in this code will indicate balanced water using the Langelier Saturation Index or other indices.	
<i>Water Clarity</i>	5.7.4.5	<i>Water Clarity</i>	
<i>Meet Standards</i>	5.7.4.5.1	Water in AQUATIC VENUES shall be maintained clear and meet water clarity standards outlined in MAHC Section 5.7.6.	
<i>Temperature</i>	5.7.4.6	<i>Temperature</i>	B
<i>Maximum</i>	5.7.4.6.1	Water temperature for warm water for INCREASED RISK AQUATIC VENUES shall remain at or below 104° F.	

**Model Aquatic Health Code:
Disinfection and Water Quality Draft CODE
6.0 Policies and Management**

NOTE: When addressing some of the comments related to the use of cyanuric acid and stabilized chlorine products in different settings, it became apparent that the revised Fecal Incident Response guidance no longer addressed aquatic venues using these products and needed to be altered. The following language is an update to the Fecal Blood Vomit Module provisions for the Fecal Incident Response Protocol. The following provisions will be included in the full MAHC draft.

Key word	Section	Code	Grade
<i>Treated</i>	6.5.2.3	<p>POOL water that has been contaminated by feces, vomit, or blood shall be treated as follows:</p> <ol style="list-style-type: none"> 1) Check to ensure that the water’s PH is 7.5 or lower and adjust if necessary; 2) Verify and maintain water temperature at 77°F (25°C) or higher; 3) Operate the filtration/recirculation system while the POOL reaches and maintains the proper free CHLORINE concentration during the remediation process; 4) Test the CHLORINE residual at multiple sampling points to ensure the proper free CHLORINE concentration is achieved throughout the POOL for the entire DISINFECTION time; and 5) Use only non-stabilized chlorine products to raise the free chlorine levels during the remediation. 	<i>Treated</i>
<i>Formed-stool</i>	6.5.3.1	<p>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 <i>(or an equivalent time and concentration to reach the CT value)</i> before reopening the AQUATIC VENUE.</p>	<i>Formed-stool</i>
<i>Pools containing chlorine stabilizers</i>	6.5.3.1.1	<p>In pool water that contains cyanuric acid or a stabilized chlorine product, water shall be treated by doubling the inactivation time required under MAHC 6.5.3.1. Measurement of the inactivation time required shall start when the AQUATIC VENUE reaches the intended free chlorine level.</p>	

<i>Diarrheal-stool</i>	6.5.3.2	Diarrheal-stool contaminated water shall have the FREE CHLORINE RESIDUAL checked and the FREE CHLORINE RESIDUAL raised to 20.0 mg/L and maintained for at least 12.75 hours (<i>or an equivalent time and concentration to reach the CT value</i>) before reopening the AQUATIC VENUE.	<i>Diarrheal-stool</i>
<i>Pools containing chlorine stabilizers</i>	6.5.3.2.1	In pool water that contains cyanuric acid or a stabilized chlorine product, water shall be treated by: <ol style="list-style-type: none">1) Circulating the water through a secondary disinfection system to reduce the number of <i>Cryptosporidium</i> oocysts in the aquatic venue below 1 oocyst/100ml as outlined in MAHC 4.7.3.3.2.4 or,2) Draining the aquatic venue completely or,3) Lowering the pH to 6.5, raising the free chlorine residual to 40 mg/L using a non-stabilized chlorine product, and maintaining at 40mg/L for at least 30 hours or an equivalent time and concentration needed to reach the CT value. Measurement of the inactivation time required shall start when the aquatic venue reaches the intended free chlorine level.	
<i>Vomit</i>	6.5.3.3	Vomit-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 (<i>or an equivalent time and concentration to reach the CT value</i>) before reopening the AQUATIC VENUE.	<i>Vomit</i>
<i>Pools containing chlorine stabilizers</i>	6.5.3.3.1	In pool water that contains cyanuric acid or a stabilized chlorine product, water shall be treated by doubling the inactivation time required under MAHC 6.5.3.3. Measurement of the inactivation time required shall start when the AQUATIC VENUE reaches the intended free chlorine level.	