2024 Model Aquatic Health Code

Code Language

5th Edition, December 2024

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2024 Model Aquatic Health Code, 5th Edition
CODE LANGUAGE
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This information is distributed solely as guidance for the purpose of assisting local, state, territorial, and tribal public health agencies; aquatic facility inspection programs; the aquatics sector; building officials; and other parties to promote public health at public aquatic facilities. This document does not address all public health concerns associated with public aquatic facility use. It is the responsibility of the user of this document to establish appropriate public health practices and determine the applicability of regulatory limitations prior to each use.

Foreword

Swimming, relaxing, and playing in water have been global pastimes throughout written history. Twentieth-century advances in aquatics—combining disinfection, filtration, and recirculation systems—led to an explosion in the use of residential and public aquatic venues (e.g., pools, hot tubs, and water playgrounds). As residential and public pool use has swept across the United States, leisure time with family and friends in and around the pool has increased. Advances in public aquatic facility design have pushed the horizons of aquatic facilities from the traditional rectangular community pool to the multi-venue waterpark hosting tens of thousands of users per day. Indoor public aquatic facilities have transformed pools and waterparks into year-round attractions. At the same time, research has demonstrated the physical and psychosocial benefits of aquatics for all age groups.

However, these aquatics sector changes—combined with changes in the general population, emergence of pathogens protected from chlorine, and imperfect bather hygiene—have resulted in substantial increases in the number of reports of recreational water–associated outbreaks. This increase is driven by the substantial increase in the number of outbreaks associated with public aquatic venues and caused by *Cryptosporidium*. Drowning continues to claim the lives of far too many, particularly young children. Thousands of people visit U.S. emergency departments every year for pool chemical injuries. Public aquatic facility operation can be improved through engineering, education, and enforcement.[1] The increase in the number of reported outbreaks and the continued occurrence of drowning and other injuries suggest the prevention of public aquatic venue–associated illness, injury, disability, and death would benefit from building stronger environmental health regulatory programs and supporting them with strong partnerships. It also would be useful for public health officials to continue to play their strong role in overseeing design and construction, advising on operation and maintenance, and helping inform policy and management. Working in close collaboration with building code officials strengthens the overall coordination needed to prioritize public health at public aquatic facilities.

The 5th Edition of the Model Aquatic Health Code (MAHC) is the latest effort to improve the MAHC, which is a set of voluntary guidance based on science and best practices. The MAHC was developed to help programs that regulate public aquatic facilities reduce the risk of illness, injury, disability, and death in their communities (see MAHC history at https://www.cdc.gov/mahc/editions/creation.html). The MAHC is a leap forward from U.S. Centers for Disease Control and Prevention's (CDC) operational and technical manuals

[1] Centers for Disease Control and Prevention. Immediate closures and violations identified during routine inspections of public aquatic facilities - network for aquatic facility inspection surveillance, five states, 2013. Morbidity and mortality weekly report Surveillance summaries (Washington, DC : 2002). 2016 May 20;65(5):1-26.

published in 1959, 1976, and 1981 and a logical progression of CDC's Healthy Swimming program, which was started in 2001. The 2024 MAHC (5th Edition) underscores CDC's long-term involvement and commitment to improving aquatic health and safety. MAHC guidance stemmed from concern about the substantially increasing number of reported outbreaks starting in the mid-1990s.

Creation of the MAHC was the major recommendation of a 2005 national workshop, which was charged with developing recommendations to reduce the incidence of these outbreaks. Local, state, and federal public health officials and the aquatics sector formed an unprecedented 7-year collaboration to create the 2014 MAHC (1st Edition). The MAHC is being regularly updated with input from the Council for the Model Aquatic Health Code (CMAHC). The CMAHC was established to help CDC keep the MAHC up to date and current with the latest advances in the aquatics sector, while also responding to the latest public health reports of public aquatic venue–associated illness, injury, disability, and death. For each update cycle, CMAHC leads efforts to solicit, collect, and assess MAHC change requests (proposed changes to improve the MAHC); hosts a national stakeholder conference to discuss change requests; and holds a membership vote on the proposed changes. The partnership among public health, the aquatics sector, CMAHC, and academia strengthens the efforts to achieve CDC's vision of "healthy and safe aquatic experiences for everyone".

CDC

Atlanta, GA, 2024

Acknowledgments

The fourth Vote on the Code Conference was held by the Council for the Model Aquatic Health Code (CMAHC) February 15-16, 2024. CDC would like to acknowledge the hard work and dedication of CMAHC staff, CMAHC Technical Review Committee, CMAHC Technical Support Committees, CMAHC Board of Directors, and CMAHC membership for their dedication and time spent developing, assessing, discussing, and voting on Model Aquatic Health Code (MAHC) change requests (proposed changes to improve the MAHC). It is only through the dedicated efforts and contributions of experienced professionals that a scientifically sound, well-focused, and up-to-date MAHC is possible.

CDC acknowledges with immense gratitude their substantial contribution to public health in the development of the 2024 MAHC (5th Edition). They deserve our heartfelt thanks and appreciation for volunteering their time and expertise to create the 2024 MAHC (5th Edition). In addition, CDC would like to also give its thanks to all the reviewers across the country who spent a great deal of time combing through the detail of the MAHC code and annex to submit change requests and who provided public comments. Their effort was worth the time invested; the MAHC has again been greatly improved.

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1.0 Glossary of Abbreviations

AAU	Amateur Athletic Union
ACA	American Coatings Association
ACCA	Air Conditioning Contractors of America
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidance
AED	Automated External Defibrillator
AHA	American Heart Association
AHJ	Authority Having Jurisdiction
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
APSP	Association of Pool and Spa Professionals
ARC	American Red Cross
ASHI	American Safety & Health Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASL	Artificial Swimming Lagoon
ASME	American Society of Mechanical Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
ATSDR	United States Agency for Toxic Substances and Disease Registry
BCDMH	1-bromo-3-chloro-5, 5-dimethylhydantoin
BVM	Bag-Valve Mask
CCPRF	Citizen CPR Foundation
CDC	United States Centers for Disease Control and Prevention
CEL	Certified Equipment List
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEU	Continuing Education Units
CFD	Computational Fluid Dynamics
CFM	Cubic Feet Per Minute
CFOC	Caring for Our Children
CFP	Conference for Food Protection
CFR	Code of Federal Regulations
CI	Chlorine Institute
CMAHC	The Council for the Model Aquatic Health Code
CoSTR	Consensus on Science and Treatment Recommendations

CPR	Cardiopulmonary Resuscitation
CPSC	United States Consumer Product Safety Commission
CSA	Canadian Standards Association
CYA	Cyanuric Acid
DBDMH	Dibromodimethylhydantoin
DBP	Disinfection Byproduct
DCOF	Dynamic Coefficient of Friction
DSA	Designated Swimming Area
EAP	Emergency Action Plan
ECC	Emergency Cardiovascular Care
ECCU	Emergency Cardiovascular Care Update
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FAC	Free Available Chlorine
FDA	United States Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FPM	Feet Per Minute
GFCI	Ground-Fault Circuit Interrupter
GPM	Gallons Per Minute
HazCom	Hazard Communication Standard
HMIS	Hazardous Material Identification System
HOBr	Hypobromous Acid
HOCl	Hypochlorous Acid
HSC	California Health and Safety Code
HSEESS	Hazardous Substance Emergency Events Surveillance System
HVAC	Heating, Ventilation, and Air Conditioning
IAEI	International Association of Electrical Inspectors
IAF	International Aquatic Foundation
IAPMO	International Association of Plumbing and Mechanical Officials
IARC	International Agency for Research on Cancer
IBC	International Building Code
ICBO	International Council of Building Officials
ICC	International Code Council
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America

IFC	International Fire Code
ILCOR	International Liaison Committee on Resuscitation
IMC	International Mechanical Code
IPC	International Plumbing Code
ISEA	International Safety Equipment Association
ISO	International Organization for Standardization
ISPSC	International Swimming Pool and Spa Code
MAHC	Model Aquatic Health Code
MERV	Minimum Efficiency Reporting Value
METS	Metabolic Equivalents
MRC	Moisture Removal Capacity
MRE	Moisture Removal Efficiency
MSBL	Maximum Sustainable Bather Load
NCAA	National Collegiate Athletic Association
NEC	National Electrical Code
NEHA	National Environmental Health Association
NEISS	National Electrical Injury Surveillance System
NEMA	National Electrical Manufacturers Association
NFHS	National Federation of State High School Associations
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NPDS	National Poison Data System
NPSH	Net Positive Suction Head
NRPA	National Recreation and Park Association
NRR	Noise Reduction Ratings
NRTL	Nationally Recognized Testing Laboratory
NSF	NSF International (formerly National Sanitation Foundation)
NSPF	National Swimming Pool Foundation
OEM	Original Equipment Manufacturer
ÖNORM	Österreichisches Normungsinstitut (Austrian Standards Institute)
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PERC	Propane Education and Research Council

PHMB	Polyhexamethylene Biguanide Hydrochloride
PMRA	Health Canada Pest Management Regulatory Agency
PPE	Personal Protective Equipment
PPM	Parts Per Million
PVC	Polyvinyl Chloride
PVC-P	Plasticized Polyvinyl Chloride
PWTAG	Pool Water Treatment Advisory Group
RED	Reduction Equivalent Dose
RLV	Relative Limit Value
RP	Reduced Pressure Principle Assembly
RPZ	Reduced Pressure Zone
RWI	Recreational Water–Associated Illness
SCBA	Self-Contained Breathing Apparatus
SCI	Spinal Cord Injury
SDS	Safety Data Sheet
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SOFAs	Submerged Suction Outlets Fitting Assemblies
STC	Sound Transmission Class
SVRS	Safety Vacuum Release System
TB	Total Bromine
TDH	Total Dynamic Head
TDS	Total Dissolved Solids
THM	Trihalomethane
TLV	Threshold Limit Value
UL	Underwriters Laboratories
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
USACE	United States Army Corps of Engineers
USC	United States Code
USDOE	United States Department of Energy
USLSC	United States Lifeguarding Standards Coalition
USPSHTC	Uniform Swimming Pool, Spa, and Hot Tub Code
UV	Ultraviolet
UVT	Ultraviolet Transmittance
VFD	Variable Frequency Drive

VGB Act	Virginia Graeme Baker Pool and Spa Safety Act
WC	Water Closet
WHO	World Health Organization
WQTD	Water Quality Testing Device
YMCA	Young Men’s Christian Association

2.0 Glossary of Terms

"Accessible Route" means access/egress standards as defined by 2010 ADA Standards for Accessible Design.

"Activity Pool" See "Pool."

"Air Delivery Rate" means the supply cfm of the air handler system(s) comprised of a combination of outside air and return air minus any exhaust air if exhausted within the air handler itself.

"Air Handling System" means equipment that brings in outdoor air into a building and removes air from a building for the purpose of introducing air with fewer contaminants and removing air with contaminants created while bathers are using aquatic venues. The system contains components that move and condition the air for temperature, humidity, and pressure control, and transport and distribute the air to prevent condensation, corrosion, and stratification, provide acceptable indoor air quality, and deliver outside air to the breathing zone.

"Agitated Water" See "Theoretical Peak Occupancy."

"Alpha Bar" See "Average Sound Absorption Coefficient."

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

"Aquatic Facility or Aquatic Venue Enclosure" means an enclosure, as defined herein, that surrounds and secures an aquatic facility or aquatic venue.

"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 purposes 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.

- **"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 ages less than 5 years) 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 ages less than 5 years as well as therapy pools.
- **"Lazy River"** means a channeled flow of water of near−constant depth in which the water is moved by pumps or other means of propulsion to provide a river−like flow that transports bathers over a defined path. A lazy river may include play features and devices. A lazy river may also be referred to as a tubing pool, leisure river, leisure pool or a current channel.
- **"Spa"** means a structure intended for either warm or cold water where prolonged exposure is not intended. Spa structures are intended to be used for bathing or other recreational uses and are not usually drained and refilled after each use. It may include, but is not limited to, hydrotherapy, air induction bubbles, and recirculation.
- **"Special Use Aquatic Venue"** means aquatic venues that do not meet the intended use and design features of any other aquatic venue or pool listed/identified in this Code.

"Artificial Swimming Lagoon" (ASL) means a large format aquatic venue. The ASL is designed to mimic a natural water body and consists of one or more designated swimming areas with the remainder of the lagoon designated for water sports and non-traditional uses, including: Kayaking, Paddle-boarding, Windsurfing, Boating, and SCUBA diving training,

"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, installations, or procedures.

"Automated Controller" means a system of at least one chemical probe, a controller, and auxiliary or integrated component that senses the level of one or more water parameters and provides a signal to other equipment to maintain the parameters within a user-established range.

"Available Chlorine" See "Chlorine."

"Average Sound Absorption Coefficient" (Alpha Bar) means the weighted average sound absorption coefficient for a room calculated by weighting the sound absorption coefficients of the individual surfaces in the room according to their respective areas and taking the arithmetic average as follows (especially in the 500 Hz and 1,000 Hz frequencies): And m2 (or ft2); where areas of the individual sound absorptive surfaces, m2 (or ft2) respective individual absorption coefficients (dimensionless). A sound absorption coefficient is of a surface, in a specified frequency band, the fraction of the randomly incident sound power which is absorbed (or otherwise not reflected) by a material metric: sabin/m2.

"Backflow" means the undesirable reversal of flow of water or other substances through a cross-connection and into the piping of the source water system. There are two types of backflow: backpressure and backsiphonage.

"Background Noise" means noise from all sources unrelated to a particular sound that is the object of interest. Background noise may include airborne, structure borne and instrument noise.

"Backpressure" means a type of backflow where the hydraulic condition, caused by a difference in water pressure, causes an undesirable reversal of the flow as a result of a higher water pressure in the system than in its supply.

"Backsiphonage" means a type of backflow where the reversal of flow of water is due to a drop in pressure of the supply in the source water system.

"Barrier" means an obstacle intended to deter direct access from one point to another.

"Bather" means a person at an aquatic venue who has contact with water either through spray or partial or total immersion. The term bather as defined, also includes staff members, and refers to those users who can be exposed to contaminated water as well as potentially contaminate the water.

"Bather Count" means the number of bathers in an aquatic venue at any given time.

"Best Practice" means a technique or methodology that, through experience and research, has been proven to reliably lead to a desired result.

"Body of Water" (per NEC, q.v.) means any aquatic venue holding standing water, whether permanent or storable.

"Breakpoint Chlorination" means the conversion of inorganic chloramine compounds to nitrogen gas by reaction with Free Available Chlorine. When chlorine is added to water containing ammonia (from urine, sweat, or the environment, for example), it initially reacts with the ammonia to form monochloramine. If more chlorine is added, monochloramine is converted into dichloramine, which decomposes into nitrogen gas, hydrochloric acid, and chlorine. The apparent residual chlorine decreases since it is partially reduced to hydrochloric acid. The point at which the drop occurs is referred to as the "breakpoint". The amount of free chlorine that must be added to the water to achieve breakpoint chlorination is approximately 10 times the

amount of combined chlorine in the water. As additional chlorine is added, all inorganic combined chlorine compounds disappear, resulting in a decrease in eye irritation potential and "chlorine odors."

"Bulkhead" means a movable partition that physically separates a pool into multiple sections.

"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."

"Chemical Storage Space" means a space in an aquatic facility used for the storage of pool chemicals such as acids, salt, or corrosive or oxidizing chemicals.

"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.

- **"Available Chlorine"** means the amount of chlorine in the +1 oxidation state, which is the reactive, oxidized form. In contrast, chloride ion (Cl–) is in the -1 oxidation state, which is the inert, reduced state. Available Chlorine is subdivided into Free Available Chlorine and Combined Available Chlorine. Pool chemicals containing Available Chlorine are both oxidizers and disinfectants. Elemental chlorine (Cl2) is defined as containing 100% available chlorine. The concentration of Available Chlorine in water is normally reported as ppm (mg/L) "as Cl2", that is, the concentration is measured on a Cl2 basis, regardless of the source of the Available Chlorine.
- **"Combined Available Chlorine"** or **"Combined Chlorine"** or "CAC" or "CC" means the concentration of available chlorine present in the form of inorganic or organic chloramines. Combined available chlorine is less reactive than free available chlorine and organic chloramines are generally less reactive oxidizers than the inorganic chloramines. Combined chlorine is determined by taking the difference between the Total Chlorine (TC) and DPD-FC concentrations. CC = TC – DPD-FC.
- **"Cyanurate-bound available chlorine"** or "CBC" means the concentration of available chlorine that is bound to cyanurate.
- **"DPD Free Chlorine"** or "DPD-FC" means the FC ("free chlorine") concentration from DPD-based test methods. The DPD-based test result for FC includes cyanurate-bound available chlorine as well as HOCl and OCl Chlorine -, that is, DPD-FC = FAC + CBC. The terms DPD-FC and FAC would be interchangeable only in the absence of cyanuric acid.
- **"Free Available"** or "FAC" or "Free Chlorine Residual" means the portion of the total available chlorine that is not "combined chlorine" or "cyanurate-bound available chlorine" and is primarily present as hypochlorous acid (HOCl) or hypochlorite ion (OCl-). Molecular chlorine (Cl2), trichloride (Cl3-), and chlorine monoxide (Cl2O) are also present at very low concentrations, depending on chlorine ion concentration, and these compounds are also counted as free available chlorine. The pH of the water determines the relative amounts of HOCl and OCl-. HOCl is a very effective biocide and is the active biocide in pool water. OCl- is also a biocide but acts more slowly

than HOCl. Thus, chlorine is a more effective biocide at low pH than at high pH. A free chlorine residual must be maintained for adequate disinfection.

- **"Total Available Chlorine"** means the "TC" concentration from DPD-based test methods with iodide reagent added. All forms of available chlorine which react with iodide are measured as Total Available Chlorine (TC).

"Circulation Path" means an exterior or interior way of passage from one part of an aquatic facility to another for pedestrians, including, but not limited to walkways, pathways, decks, and stairways.

"Cleansing Shower" See "Shower."

"Climate Control System" means a combination of the pieces of equipment designed to control the temperature, humidity, introduce ventilation air and maintain building negative pressure.

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

"Combustion Device" means any appliance or equipment using fire. These include, but may not be limited to, gas or oil furnaces, boilers, pool heaters, domestic water heaters, etc.

"Construction Joint" means a watertight joint provided to facilitate stopping places in the construction process. Construction joints also serve as contraction joints which control cracking.

"Contaminant" means a substance that soils, stains, corrupts, or infects another substance by contact or association.

"Contamination Response Plan" means a plan for handling contamination from formed-stool, diarrheal-stool, vomit, and blood.

"Corrosive Material" means pool chemicals, fertilizers, cleaning chemicals, oxidizing cleaning materials, salt, de-icing chemicals, other corrosive or oxidizing materials, pesticides, and such other materials which may cause injury to people or damage to the building, air-handling equipment, electrical equipment, safety equipment, or fire-suppression equipment, whether by direct contact or by contact via fumes or vapors, whether in original form or in a foreseeably likely decomposition, pyrolysis, or polymerization form. Refer to labels and SDSs.

"Crack" means any and all breaks in the structural shell of a pool vessel or deck.

"Cross-Connection" means a connection or arrangement, physical or otherwise, between a potable water supply system and a plumbing fixture, tank, receptor, equipment, or device, through which it may be possible for non- potable, used, unclean, polluted, and contaminated water, or other substances to enter into a part of such potable water system under any condition.

"CT Inactivation Value" means the concentration of a particular disinfectant (C) multiplied by the contact time in minutes (T) needed for inactivation of a particular microorganism. The CT value is approximately constant; therefore, the higher the concentration of the disinfectant, the shorter the contact time required for inactivation. The CT inactivation value applies to a given level of inactivation, for example a 3-log (99.9%) reduction and can vary with pH or temperature so these values must also be supplied to allow comparison between values.

"Deck" means surface areas serving the aquatic venue, including the dry deck, perimeter deck, and pool deck.

- **"Dry Deck"** means all pedestrian surface areas within the aquatic venue enclosure not subject to frequent splashing or constant wet foot traffic. The dry deck is not perimeter deck or pool deck, which connects the pool to adjacent amenities, entrances, and exits. Landscape areas are not included in this definition.

- **"Perimeter Deck"** means the hardscape surface area immediately adjacent to and within 4 feet (1.2 m) of the edge of the swimming pool also known as the "wet deck" area.
- **"Pool Deck"** means surface areas serving the aquatic venue, beyond perimeter deck, which is expected to be regularly trafficked and made wet by bathers.
- **"Wet Deck"** means the sum of the perimeter deck and pool deck.

"Design Professional" means a person who is registered or licensed to practice their respective design profession as defined by the local, state, territorial, federal, and tribal laws governing professional practice within the jurisdiction where the project is to be constructed.

"Designated Swimming Area" (DSA) means a zone of water within an Artificial Swimming Lagoon used for swimming, wading, or bathing. Typically, a DSA is separated from the water sports area using a rope and float line or similar device approved by the Authority Having Jurisdiction. Constant flow of treated water into DSAs ensure water quality. The flowing water displaces potentially contaminated water from the DSAs, creating a positive hydraulic gradient from DSAs into the water sports area. Water is removed from the water sports area and treated before it is returned to the DSAs. Typically, DSAs are shallower than the open-water areas used for boating, kayaking, and paddle-boarding. Swimming, wading, and bathing are not permitted outside of DSAs.

"Diaper-Changing Station" means a hygiene station that includes a diaper-changing unit, handwashing sink, soap and dispenser, a means for drying hands, trash receptacle, and disinfectant products to clean after use.

"Diaper-Changing Unit" means a diaper-changing surface that is part of a diaper-changing station.

"Dichloramine" means a disinfection byproduct formed when chlorine binds to nitrogenous waste in pool water to form an amine-containing compound with two chlorine atoms (NHCl2). It is a known acute respiratory and ocular irritant.

"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 Byproduct" (DBP) 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).

"Diving Pool" See "Pool."

"Drop Slide" See "Slide."

"Dry Deck" See "Deck."

"Emergency Action Plan" (EAP) means a plan that identifies the objectives that need to be met for a specific type of emergency, who will respond, what each person's role will be during the response and what equipment is required as part of the response.

"Enclosure" means an uninterrupted constructed feature or obstacle used to surround and secure an area that is intended to effectively prevent unpermitted, uncontrolled, and unfettered access. It is designed to resist climbing and to prevent passage through it and under it. Enclosure can apply to aquatic facilities or aquatic venues.

"EPA Registered" means all products regulated and registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) by the EPA.

"Equipment Room or Area" means a space intended for the operation of pool pumps, filters, heaters, and controllers. This space is not intended for the storage of hazardous pool chemicals.

"Exit Gate" means an emergency exit, which is a gate or door allowing free exit at all times.

"Expansion Joint" means a watertight joint provided in a pool vessel used to relieve flexural stresses due to movement caused by thermal expansion/contraction.

"Fixture" See "Plumbing Fixture" or "Hygiene Fixture."

"Flat Water" See "Theoretical Peak Occupancy."

"Floatation Tank" (a.k.a. Float Tank, Float Room/Pod/Spa/Chamber, Isolation Tank, or Sensory Deprivation Tank) means a tub that contains a saturated solution of magnesium sulfate having a specific gravity of 1.23 to 1.3, provides a light and sound reduced environment, and is maintained at a temperature of approximately 92–96°F / 33.3–35.6°C.

"Floatation Tank Solution" means a saturated solution of magnesium sulfate having a specific gravity of 1.23 to 1.3.

"Flume" means the riding channels of a waterslide which accommodate riders using or not using mats, tubes, rafts, and other transport vehicles as they slide along a path lubricated by a water flow.

"Foot Bath" means standing water in which bathers or aquatics staff rinse their feet.

"Free Chlorine Residual" or **"Free Available Chlorine"** See "Chlorine."

"Ground-Fault Circuit Interrupter" (GFCI) means a device for protection of personnel that de-energizes an electrical circuit or portion thereof in the event of excessive ground current.

"Handwashing Station" means a location which has a handwashing sink, adjacent soap with dispenser, hand drying device or paper towels and dispenser, and trash receptacle.

"Hot Water" See "Theoretical Peak Occupancy."

"Hygiene Facility" means a structure or part of a structure that contains toilet, shower, diaper-changing unit, handwashing station, and dressing capabilities serving bathers and patrons at an aquatic facility.

"Hygiene Fixtures" means all components necessary for hygiene facilities including plumbing fixtures, diaper- changing stations, handwashing stations, trashcans, soap dispensers, paper towel dispensers or hand dryers, and toilet paper dispensers.

"Hyperchlorination" means the intentional and specific raising of free available chlorine concentrations for a prolonged period of time to inactivate pathogens following a fecal or vomit release in an aquatic venue.

"Imminent Health Hazard" means a substantial threat or danger to health that is considered to exist when there is evidence sufficient to show that a product, practice, circumstance, or event creates a situation that requires immediate correction or cessation of operation to prevent injury based on the number of potential injuries and the nature, severity, and duration of the anticipated injury or illness.

"Increased Risk Aquatic Venue" See "Aquatic Venue."

"Indoor Aquatic Facility" means a physical place that contains one or more aquatic venues and the surrounding bather and spectator/stadium seating areas within a structure that meets the definition of "Building" per the International Building Code (IBC). Indoor Aquatic Facility does not include equipment, chemical storage, or bather hygiene rooms or any other rooms with a direct opening to the aquatic facility. Otherwise known as a natatorium.

"Infinity Edge" means a pool wall structure and adjacent perimeter deck that is designed in such a way where the top of the pool wall and adjacent deck are not visible from certain vantage points in the pool or from the opposite side of the pool. Water from the pool flows over the edge and is captured and treated for reuse through the normal pool filtration system. They are often also referred to as "vanishing edges," "negative edges," or "zero edges."

"Inlet" means wall or floor fittings where treated water is returned to the pool.

"Interactive Water Play Aquatic Venue" means any indoor or outdoor installation that includes sprayed, jetted, or other water features where water contacts bathers, whether recirculated or non-recirculated (also known as "single pass"), 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, and wet decks.

"Interior Space" means any substantially enclosed space having a roof and having a wall or walls which might reduce the free flow of outdoor air. Ventilation openings, fans, blowers, windows, doors, etc., shall not be construed as allowing free flow of outdoor air.

"Island" means a structure inside a pool where the perimeter is completely surrounded by the pool water and the top is above the surface of the pool.

"Landing Pool" See "Pool."

"Lazy River" See "Aquatic Venue."

"Lifeguard Supervisor" means an individual responsible for the oversight of lifeguard performance and emergency response at an aquatic facility, who has successfully completed a lifeguard supervisor training course that meets the requirements of this code, and who holds a valid certificate for such training.

"mg/L" means milligrams per liter and is the equivalent metric measure to parts per million (ppm).

"Moisture Removal Capacity" means the amount of condensate produced by the climate control equipment which includes the effects of reheat coils, circulating fans and other components in the air stream; excluding supplementary heating, cooling, or outdoor air; and expressed in pounds of moisture/hour.

"Moisture Removal Efficiency" (MRE) means a ratio of the MRC in pounds of moisture/hour to the power input values in kilowatts at any given set of Rating Conditions expressed in pounds of moisture/kilowatt hour.

"Monitoring" 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.

"Moveable Floors" means a pool floor whose depth varies through the use of controls.

"No Diving Marker" means a sign with the words "No Diving" and the universal international symbol for "No Diving" pictured as an image of a diver with a red circle with a slash through it.

"Noise Criterion" means the single number rating that is somewhat sensitive to the relative loudness and speech interference properties of a given noise spectrum. The method consists of a family of criterion curves extending from 63 to 8,000 Hz and a tangency rating procedure. The criterion curves define the limits of octave band spectra that must not be exceeded to meet occupant acceptance in certain spaces.

"Non-Recirculated" means that the water used to fill an aquatic venue or to feed aquatic features is not recirculated through a treatment system for filtration and disinfection, but rather is sourced from an approved water supply used only once in/on the aquatic venue and gets disposed of with a proper wastewater disposal method. For example, at a non-recirculated Interactive Water Play Aquatic Venue, water sprayed from an aquatic feature comes directly from the water supply, is used only once, and gets disposed of through sanitary sewer drains).

"Non-Substantial Alteration" means the alteration, modification, or renovation of an aquatic facility or an aquatic venue where the total cost of the work is 50% or less of the replacement cost of the aquatic facility or the aquatic venue.

"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 either increasing the number of oxygen atoms or reducing the number of electrons of the contaminant or other chemical reaction, which allows the contaminant to be more readily removed from the water or made more soluble in the water.

"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.

"Peninsula / Wing Wall" means a structural projection into a pool intended to provide separation within the body of water.

"Perimeter Deck" See "Deck."

"Perimeter Gutter System" means a weir or trough around the perimeter of a swimming pool that is used to skim the surface of the water and return the water to the treatment system.

"pH" means 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 hypochlorous acid (HOCl) ionization occurs and chlorine disinfectants decrease in effectiveness.

"Plumbing Fixture" means a receptacle, fixture, or device that is connected to a water supply system or discharges to a drainage system or both and may be used for the distribution and use of water; for example: toilets, urinals, showers, and hose bibs.

"Pool" means a subset of aquatic venues designed to have standing water for total or partial bather immersion. This does not include spas.

- **"Activity Pool"** means a water attraction designed primarily for play activity that uses constructed features and devices including pad walks, flotation devices, and similar attractions.
- **"Diving Pool"** means a pool used exclusively for diving.
- **"Landing Pool"** means an aquatic venue or designated section of an aquatic venue located at the exit of one or more waterslide flumes. The body of water is intended and designed to receive a bather emerging from the flume for the purpose of terminating the slide action and providing a means of exit to a deck or walkway area.
- **"Skimmer Pool"** means a pool using a skimmer system.
- **"Surf Pool"** means any pool designed to generate waves dedicated to the activity of surfing on a surfboard or analogous surfing device commonly used in the ocean and intended for sport as opposed to general play intent for wave pools.
- **"Therapy Pool"** means a pool used exclusively for aquatic therapy, physical therapy, 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).
- **"Wave Pool"** means any pool designed to simulate breaking or cyclic waves for purposes of general play. A wave pool is not the same as a surf pool, which generates waves dedicated to the activity of surfing on a surfboard or analogous surfing device commonly used in the ocean and intended for sport as opposed to general play intent for wave pools.

"Pool Deck" See "Deck."

"Pool Slide" See "Slide."

"Public Water Systems" means water systems including community water systems, non-transient/non-community water systems, or transient non-community water systems with exceptions as noted by AHJ and EPA.

"Purge" means to introduce a large volume of outdoor air to flush the interior space.

"Qualified Lifeguard" means an individual who has successfully completed an AHJ-recognized lifeguard training course offered by an AHJ-recognized training agency, holds a current certificate for such training, has met the pre-service requirements, and is participating in continuing in-service training requirements of the aquatic facility.

"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.

"Raceway" means an enclosed channel of metallic or nonmetallic materials designed expressly for holding wires, cables, busbars, or additional functions as permitted.

"Recessed Steps" means a way of ingress/egress for a pool, similar to a ladder but the individual treads are recessed into the pool wall.

"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*).

"Re-entrainment" means a situation where the exhaust(s) from a ventilated source such as an indoor aquatic facility is located too close to the air handling system intake(s), which allows the exhausted air to be re-captured by the air handling system, so it is transported directly back into the aquatic facility.

"Responsible Supervisor" means an individual onsite that is responsible for water treatment operations when a "qualified operator" is not onsite at an aquatic facility.

"Reverberation" means the persistence of sound in an enclosed or partially enclosed space after the source of sound has stopped due to repeated reflections from the room surfaces; by extension, in some contexts, the sound that so persists.

"Reverberation Time – RT60" means, for airborne sound, the time it takes a reverberant sound field to decay 60 dB after the source is interrupted. If an ambient sound field limits the ability to measure 60 dB of decay, then this time can be extrapolated for the measure of the shorter decay.

“Rinse Shower” See “Shower.”

“Robotic Cleaner” means a modular vacuum system consisting of a motor-driven, in-pool suction device, either self-powered or powered through a low voltage cable, which is connected to a deck-side power supply.

"Rope and Float Line" means a continuous line not less than 1/4" (6 mm) in diameter and that is supported by buoys spaced no more than 5 feet apart to provide a visual and physical separation of the pool areas.

“Runout” means that part of a waterslide where riders are intended to decelerate and/or come to a stop. The runout is a continuation of the waterslide flume surface.

“Safety” (as it relates to construction items) means a design standard intended to prevent inadvertent or hazardous operation or use (i.e., a passive engineering strategy).

“Safety Plan” means a written document that has procedures, requirements and/or standards related to safety which the aquatic facility staff shall follow. These plans include training, emergency response, and operations procedures.

“Safety Team” means any employee of the aquatic facility with job responsibilities related to the aquatic facility’s emergency action plan.

“Safety Vacuum Release System” (SVRS) means as defined in 15 USC 8002 (5) “a vacuum release system capable of providing vacuum release at a suction outlet caused by a high vacuum occurrence due to a suction outlet flow blockage.” A SVRS may be a mechanical device installed on the exposed single main suction pipe before a filtration or feature pump or an electrical device located as an attachment to the filtration or feature pump control system or is integral with the filtration or feature pump or motor itself.

“Sanitize” means reducing the concentration of microbes to that considered safe by public health standards.

“Saturation Index” means a mathematical representation or scale representing the ability of water to deposit calcium carbonate, or dissolve metal, concrete, or grout.

“Secondary Treatment” 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.

“Shower” means a device that sprays water on the body.

- **“Cleansing Shower”** means a shower located within a hygiene facility using warm water and soap. The purpose of these showers is to remove contaminants including perianal fecal material, sweat, skin cells, personal care products, and dirt before bathers enter the aquatic venue.
- **“Rinse Shower”** means a shower typically located in the pool deck area with ambient temperature water. The main purpose is to remove dirt, sand, or organic material prior to entering the aquatic venue to reduce the introduction of contaminants and the formation of disinfection byproducts.

“Skimmer” means a device installed in the pool wall whose purpose is to remove floating debris and surface water to the filter. They shall include a weir to allow for the automatic adjustment to small changes in water level, maintaining skimming of the surface water.

“Skimmer Pool” See “Pool.”

“Skimmer System” means periodic locations along the top of the pool wall for removal of water from the pool’s surface for treatment.

“Slide” means an aquatic feature where users slide down from an elevated height into water.

- **“Drop Slide”** means a slide that drops bathers into the water from a height above the water versus delivering the bather to the water entry point.

- **"Pool Slide"** means a slide similar in construction to a playground slide used to allow users to slide from an elevated height to a pool. They shall include children's (tot) slides and all other non- flume slides that are mounted on the pool deck or within the basin of a public swimming pool.
- **"Waterslide"** means a slide that runs into a landing pool or runout through a fabricated channel with flowing water.

"Slip Resistant" means surfaces shall have a minimum dynamic coefficient of friction at least equal to the requirements of ANSI A326 for that installation as measured by the DCOF AcuTest.

"Sound Absorption" means (1) the process of dissipating sound energy and (2) the property possessed by materials, objects, and structures, such as rooms, for absorbing sound energy.

"Sound Transmission Class" (STC) means a one-number rating of the sound-blocking ability of a partition, door, window, etc., calculated in accordance with ASTM E413 from measurements of one-third-octave band sound pressure levels and sound absorption made in a laboratory and in accordance with ASTM E90.

"Spa" See "Aquatic Venue."

"Special Use Aquatic Venue" See "Aquatic Venue."

"Stadium Seating" See "Theoretical Peak Occupancy."

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

"Storage" means the condition of remaining in one space for 1 hour or more. Materials in a closed pipe or tube awaiting transfer to another location shall not be considered to be stored.

"Structural Crack" means a break or split in the pool surface that weakens the structural integrity of the vessel.

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

"Superchlorination" means the addition of large quantities of chlorine-based chemicals to kill algae, destroy odors, or improve the ability to maintain a disinfectant residual.

"Supplemental Treatment" 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.

"Surf Pool" See "Pool."

"SVRS" See "Safety Vacuum Release System."

"Theoretical Peak Occupancy" means the anticipated peak number of bathers in an aquatic venue or the anticipated peak number of occupants of the decks of an aquatic facility. This is the lower limit of peak occupancy to be used for design purposes for determining services that support occupants. Theoretical peak occupancy is used to determine the number of showers. For aquatic venues, the theoretical peak occupancy is calculated around the type of water use or space:

- **"Agitated Water"** means an aquatic venue with mechanical means (aquatic features) to discharge, spray, or move the water's surface above or below the static water line of the aquatic venue so people are standing or playing vertically. Where there is no static water line, movement shall be considered above the deck plane. Recirculation through either floor or wall inlets shall not be considered agitated water.

- **“Flat Water”** means an aquatic venue in which the water line is static except for movement made by users usually as a horizontal use as in swimming. Diving spargers do not void the flat water definition.
- **“Hot Water”** means an aquatic venue with a water temperature over 90oF (32oC).
- **“Stadium Seating”** means an area of high-occupancy seating provided above the pool level for observation.

“Therapy Pool” See “Pool.”

“Toe Ledge” See “Underwater Ledge.”

“Total Bromine” means the amount of bromine in the +1 oxidation state, which is the reactive, oxidized form. Commercially available test kits are not capable of distinguishing free bromine (Br2, HOBr, OBr-) from combined bromine (bromamines). The bromine value specified in test results is the concentration of total bromine.

“Trichloramine” means a disinfection byproduct formed when chlorine binds to nitrogenous waste in pool water to form an amine-containing compound with three chlorine atoms (NCl3). It is a known acute respiratory and ocular irritant. It has low solubility in water and is rapidly released into the air above pools where it can accumulate, particularly in indoor settings.

“Trihalomethanes” (THM) means chemical compounds in which three of the four hydrogen atoms of methane (CH4) are replaced by halogen atoms. Trihalomethanes are environmental pollutants, and many are considered carcinogenic.

"Turnover" or **"Turnover Rate"** or **“Turnover Time”** means the period of time, usually expressed in hours, required to circulate a volume of water equal to the capacity of the aquatic venue.

“Underwater Bench” means a submerged seat with or without hydrotherapy jets.

“Underwater Ledge” or **“Underwater Toe Ledge”** means a continuous step in the pool wall that allows swimmers to rest by standing without treading water.

“UV Transmissivity” means the percentage measurement of ultraviolet light able to pass through a solution.

“Wading Pool” See “Pool.”

“Waterslide” See “Slide.”

“Water Quality Testing Device” (WQTD) means a product designed to measure the level of a parameter in water. A WQTD includes a device or method to provide a visual indication of a parameter concentration and may include one or more reagents and accessory items.

“Water Replenishment System” means a way to remove water from the pool as needed and replace with make- up water to maintain water quality.

“Wave Pools” See “Pool.”

“Wet Deck” See “Deck.”

“Wing Wall / Peninsula” See “Peninsula / Wing Wall.”

“Zero Depth Entry” means a sloped entry into a pool from deck level into the interior of the pool as a means of access and egress.

3.0 Cited Standards and Laws

Nothing in this code is intended to exempt an AQUATIC FACILITY or associated AQUATIC VENUES from any applicable local, state, territorial, federal, and tribal laws. Other applicable requirements may include but are not limited to building codes, mechanical codes, plumbing codes, electrical codes, fire codes, FDA Food Code, OSHA requirements, EPA requirements, and the Code of Federal Regulations. Additional permits and inspections may be required based on the requirements of other applicable laws.

Acoustical Society of America (ASA)

- ANSI/ASA S12.60-2010/Part 1 (R2015), Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools
- ANSI/ASA S12.60-2009/Part 2 (R2014), Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

Air Conditioning Contractors of America (ACCA)

- ANSI/ACCA 10 Manual SPS-2011 (RA2017); Manual SPS HVAC Design for Swimming Pools and Spas

Air Conditioning Heating and Refrigeration Institute (AHRI)

- ANSI/AHRI Standard 910 (I-P), 2014 Standard for Performance Rating of Indoor Pool Dehumidifiers
- ANSI/AHRI Standard 920 (I-P), 2020 Standard for Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units

Air Movement Control Association (AMCA)

- AMCA 201-02 (R2011), Fans and Systems

American Coatings Association (ACA)

- Hazardous Materials Identification System (HMIS), 4th Edition

American Concrete Institute (ACI)

- ACI 302.1R-15, Guide to Concrete Floor and Slab Construction

American Heart Association (AHA)

- American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC)
- 2020 AHA Guidelines Update for CPR and ECC
- www.citizencpr.org

American National Standards Institute (ANSI)

- ANSI/ICC A117.1-2017. Accessible and Usable Buildings and Facilities
- ANSI A137.1:2017 American National Standards Specifications for Ceramic Tile

American National Standards Institute / International Aquatic Foundation (IAF)

- ANSI/IAF-9

American National Standards Institute / International Safety Equipment Association (ISEA)

- ANSI /ISEA Z308.1-2015: American National Standard – Minimum Requirements for Workplace First Aid Kits and Supplies

American Red Cross (ARC)

- American Red Cross, Lifeguarding Manual, 2017

American Safety & Health Institute (ASHI)

- ASHI CPR, AED and Basic First Aid Combination Training, 2018

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

- ANSI/ASHRAE Standard 62.1-2019: Ventilation for Acceptable Indoor Air Quality
- 2019 ASHRAE Handbook – HVAC Applications
- 2017 ASHRAE Handbook – Fundamentals

American Society of Mechanical Engineers (ASME)

- ASME A112.19.17-2010, Manufactured Safety Vacuum Release Systems (SVRS) for Residential and Commercial Swimming Pool, Spa, Hot Tub, and Wading Pool Suction Systems

ASTM International (formerly American Society for Testing and Materials) (ASTM)

- ASTM E90 – 09 (2016): Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- ASTM E413 – 16 (2016): Classification for Rating Sound Insulation
- ASTM E1477 – 98a (2017): Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating- Sphere Reflectometers
- ASTM F1346-91 (2010): Standard Performance Specification for Safety Covers and Labeling Requirements for All Covers for Swimming Pools, Spas and Hot Tubs
- ASTM F2285-04 (2016)e1: Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use
- ASTM 2374-17 (2017): Standard Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices
- ASTM F2376-117a (2021): Standard Practice for Classification, Design, Manufacture, Construction and Operation of Water Slides Systems
- ASTM F2387-04 (2012): Standard Specification for Manufactured Safety Vacuum Release Systems (SVRS) for Swimming Pools, Spas and Hot Tubs
- ASTM F2461-16e1 (2016): Standard Practice for Manufacture, Construction, Operation and Maintenance of Aquatic Play Equipment

Americans with Disabilities Act Accessibility Guidance (ADAAG)

- 2010 ADA Standards for Accessible Design

Association of Pool and Spa Professionals (APSP)

- ANSI/APSP/ICC-1 2014, American National Standard for Public Swimming Pools
- ANSI/APSP-9 2005, American National Standard for Aquatic Recreation Facilities

- ANSI/APSP-16 2017, American National Standard for Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs

Canadian Standards Association (CSA)

- Z83.8-2016/CSA 2.6-2016 – Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
- ANSI Z21.13-2017/CSA 4.9-2017 – Gas-Fired Low Pressure Steam and Hot Water Boilers
- CSA 22.1 – 2018 Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations
- CAN/CSA-C22.2 NO. 0-10 (R2015) – General Requirements – Canadian Electrical Code, Part II

Caring for Our Children (CFOC): National Health and Safety Performance Standard

- National Health and Safety Performance Standards; Guidelines for Early Care and Education Programs, 3rd Edition, 2011 (revised October 1, 2015)
- Also known as Caring for Our Children, 3rd Edition (CFOC3)
- https://nrckids.org

Chlorine Institute (CI)

- Pamphlet 82; Recommendations for Using 100 & 150 Pound Chlorine Cylinders at Swimming Pools, Edition 3, January 2015 Citizen CPR Foundation (CCPRF)
- ECCU Emergency Cardiovascular Care Update Conference
- www.citizencpr.org

Conference for Food Protection (CFP)

- Standards for Accreditation of Food Protection Managers Certification Programs, 2020 Edition

Consumer Product Safety Commission (CPSC)

- National Electronic Injury Surveillance System (NEISS) Data
- 15 USC Chapter 106, Pool and Spa Safety (as amended to 2014): Virginia Graeme Baker Pool and Spa Safety Act (VGBA)
- Interpretations and Staff Guidelines for the Virginia Graeme Baker Pool and Spa Safety Act

Environmental Protection Agency (EPA)

- EPA 815-R-06-007: Ultraviolet Disinfectant Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule, November 2006
- EPA 815-R-99-014: Alternate Disinfectants and Oxidants Guidance Manual, April 1999
- 42 USC Chapter 116, Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986
- 40 CFR 141, EPA, 816-F-09-004: National Primary Drinking Water Regulations, May 2009
- EPA 550-B-21-001: List of Lists – Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act, April 2022
- https://www.epa.gov/epcra/consolidated-list-lists

- OSWER 90-008.1, June 1990, EPA Chemical Emergency Preparedness and Prevention Advisory, Swimming Pool Chemicals: Chlorine
- USC 136 et. seq. (1996), Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- 40 CFR Subchapter E – Pesticide Programs

Food and Drug Administration (FDA)

- Food Code: 2017 Recommendations of the United States Public Health Service Food and Drug Administration

Hazardous Materials Identification System (HMIS)

- See American Coatings Association above

Health Canada Pest Management Regulatory Agency (PMRA)

- Pest Control Products Act (S.C. 2002, c. 28)
- Pesticide Product Information Database

Illuminating Engineering Society of North America (IESNA)

- IES RP-6-15 Sports and Recreational Area Lighting (2015)
- The Lighting Handbook, 10th Edition (2011)

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE Std 241-1990 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (reaffirmed in 1997)

International Association of Electrical Inspectors (IAEI)

- Soares Grounding and Bonding, 13th Edition, 2017

International Association of Plumbing and Mechanical Officials (IAPMO)

- IAPMO/ANSI UMC 1 2018 (2018 Uniform Mechanical Code)
- IAPMO/ANSI UPC 1 2018 (2018 Uniform Plumbing Code)
- IAPMO/ANSI USPSHTC 1 2018 (2018 Uniform Swimming Pool, Spa, and Hot Tub Code)

International Code Council (ICC)

- ICC 300-2017 IS-BLE: 2017 ICC Standard on Bleachers, Folding and Telescopic Seating, and Grandstands
- ICC/ANSI A117.1-2017 Standard for Accessible and Usable Buildings and Facilities
- 2018 International Building Code (IBC)
- 2018 International Fire Code (IFC)
- 2018 International Mechanical Code (IMC)
- 2018 International Plumbing Code (IPC)
- 2018 International Swimming Pool and Spa Code (ISPSC)

International Liaison Committee on Resuscitation (ILCOR)

- 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care With Treatment Recommendations (CoSTR)
- www.ilcor.org

International Organization for Standardization (ISO)

- ISO/IEC Guide 50:2014. Safety Aspects – Guidelines for Child Safety in Standards and Other Specifications
- ISO9000: 2015; Quality management systems – Fundamentals and vocabulary

National Collegiate Athletic Association (NCAA)

- 2017–18 and 2018–19 NCAA Men's and Women's Swimming and Diving Rules

National Electrical Manufacturers Association (NEMA)

- NEMA 250-2014, Enclosures for Electrical Equipment (1,000 V Maximum)
- ANSI/NEMA Z535, 2011 (R2017): Safety Alerting Standards

National Federation of State High School Associations (NFHS)

- 2021–22 NFHS Swimming and Diving Rules Book

National Fire Protection Association (NFPA)

- NFPA 1: Fire Code, 2018 Edition
- ANSI Z223.1/NFPA 54: National Fuel Gas Code, 2018 Edition
- NFPA 70: National Electrical Code (NEC), 2020 Edition
- NFPA 70: National Electrical Code (NEC) Handbook
- NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, 2016 Edition
- NFPA 400: Hazardous Materials Code, 2016 Edition
- NFPA 5000: Building Construction and Safety Code, 2018 Edition
- NFPA 652: Standard on the Fundamentals of Combustible Dust, 2016 Edition
- NFPA 704: Standard System for the Identification of the Hazards of Materials for Emergency Response, 2017 Edition

National Institute for Occupational Safety and Health (NIOSH)

- NIOSH Pocket Guide to Chemical Hazards, September 2007, (NPG) (DHHS (NIOSH) Publication No, 2005-149)
- 42 CFR Part 84, Approval of Respiratory Protective Devices, 1995
- Certified Equipment List (CEL)

National Oceanic and Atmospheric Administration (NOAA)

- NOAA Technical Memorandum ERL PMEL-67, Eyeball Optics of Natural Waters: Secchi Disk Science, Rudolph W. Preisendorfer, Pacific Marine Environmental Laboratory, Seattle, WA, April 1986.

National Recreation and Park Association (NRPA)

- Aquatic Facility Operator Manual, 7th Edition

National Swimming Pool Foundation (NSPF)

- Pool & Spa Operator™ Handbook, 2017 Edition

NSF International (NSF)

- NSF/ANSI 14 - 2016b, Plastics Piping System Components and Related Materials
- NSF/ANSI 50 - 16a, Equipment for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities (2017)
- NSF/ANSI 60 – 2020, Drinking Water Treatment Chemicals – Health Effects
- NSF/ANSI 61–2020, Drinking Water System Components – Health Effects

Occupational Safety and Health Administration (OSHA)

- 29 CFR 1910.304 Wiring design and protection
- 29 CFR 1910.1000 Air Contaminants
- 29 CFR 1910.1030 Bloodborne Pathogens
- 29 CFR 1910.1200 Hazard Communication
- 29 CFR 1910.1200(g) Safety Data Sheets (SDS)

Österreichisches Normungsinstitut (ÖNORM)

- Austrian Standards Institute

Pool Water Treatment Advisory Group (PWTAG)

- Swimming Pool Water: Treatment and Quality Standards for Pools and Spas, 3rd Edition, 2017

Propane Education and Research Council (PERC)

- Instruction Sheet IV: Identifying and Correcting Burner Problems

Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

- SMACNA HVAC Systems Duct Design, 4th Edition, 2006

Underwriters Laboratories (UL)

- UL 50 2015-10-16 Enclosures for Electrical Equipment, Non-Environmental Considerations
- UL 50E 2020-10-16 Enclosures for Electrical Equipment, Environmental Considerations
- UL 379 2013-06-19 Standard for Power Units for Fountain, Swimming Pool, And Spa Luminaries
- UL 399 2017-03-20 Standard for Drinking- Water Coolers
- UL 508 2018-01-28 Standard for Industrial Control Equipment
- UL 676 2015-08-10 Standard for Underwater Luminaries and Submersible Junction Boxes
- UL 727 2018-01-31 Standard for Oil-Fired Central Furnaces
- UL 1081 2016-08-09 Standard for Swimming Pool Pumps, Filters, and Chlorinators
- UL 1241 2003-06-11 Standard for Junction Boxes for Swimming Pool Luminaries
- UL 1777 2015-10-02 Standard for Chimney Liners

- UL 1995 2015-07-31 Heating and Cooling Equipment
- UL 2075 2013-03-05 Standard for Gas and Vapor Detectors and Sensors
- UL 2452 2006-04-21 Outline of Investigation for Electric Swimming Pool and Spa Cover Operators
- UL 2759 2011-09-26 Standard for Sustainability for Hard Surface Cleaners
- UL 2818 2013-03-29 GREENGUARD Certification Program for Chemical Emissions for Building Materials, Finishes, and Furnishings
- UL 8750 2015-09-15 Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products
- UL 60335-2-1000 2017-09-29 Standard for Household and Similar Electrical Appliances: Particular Requirements for Electrically Powered Pool Lifts
- UL 61010-1 2012-05-11 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements

U.S. Army Corps of Engineers (USACE)

- USACE Air Leakage Test Protocol for Building Envelopes - Version 3: May 11, 2012
- https://docslib.org/doc/10657799/usace-air-leakage-test-protocol-for-building-envelopes-version-3-2012-05-11-1

U.S. Codes: State Codes

- California Health and Safety Code (HSC), Article 4. Lead Materials, Section 116875, January 1, 2009
- Florida Administrative Code, Chapter 64E-9 Public Swimming Pools and Bathing Places, July 20, 2016
- Hawaii Administrative Rules, Title 11, Chapter 10, Public Swimming Pools, July 15, 2002
- Illinois Swimming Facility Code, Title 77, Section 820, October 4, 2013
- New York Uniform Code, Title 10, Part 6, Subpart 6-1 Swimming Pools, July 6, 2011
- Ohio Administrative Code, Chapter 3701-31 Public Swimming Pools or Spas, April 1, 2011
- Oregon Administrative Rules, Chapter 333 – Division 60, Public Swimming Pools, September 1, 2014
- Texas Administrative Code, Title 25, Chapter 265, Subchapter L, Public Swimming Pools and Spas, September 1, 2004
- Wisconsin Administrative Code, Chapter SPS 390, Design and Construction of Public Swimming Pools and Water Attractions, March 1, 2009

U.S. Coast Guard

- 33 CFR 175.15, Personal Floatation Devices, September 22, 2014

U.S. Department of Energy (USDOE)

- USDOE Air Leakage Testing and Air Sealing in Existing Multifamily Units, October 2012
- https://www1.eere.energy.gov/buildings/publications/pdfs/building_america/air_sealing_multifamily.pdf

USA Diving

- USA Diving Competitive and Technical Rules, 2018

USA Swimming

- USA Swimming 2020 Rulebook

Virginia Graeme Baker Pool and Spa Safety Act (VGB Act)

- 15 USC Chapter 106, Pool and Spa Safety (as amended to 2014)
- Available at: https://www.poolsafely.gov/wp- content/uploads/2016/04/pssa.pdf

Water Environment Federation/International Ultraviolet Association (WEF/IUVA)

- Ultraviolet Disinfection for Wastewater
- ISBN: 978-1-57278-312-6 (April 2015)

World Aquatics

- World Aquatics Facilities Rules 2021-2025
- Valid as of August 5, 2001

World Health Organization (WHO)

- Guidelines for Safe Recreational Water Environments – Volume 2 Swimming Pools and Similar Environments, 2006

YMCA of the USA (YMCA)

- On the Guard: The YMCA Lifeguard Manual, 2016 Edition

4.0[A] 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.

Note: Section numbers with superscript "A" (e.g., 4.0[A]) denote a corresponding discussion in the Annex to the Model Aquatic Health Code.

4.1 Plan Submittal

4.1.1 Plan Submittal

4.1.1.1 Purpose AQUATIC FACILITY construction plans shall be designed to provide sufficient clarity to indicate the location, nature, and extent of the work proposed.

4.1.1.2 Conform AQUATIC FACILITY construction plans shall show in detail that the AQUATIC FACILITY will conform to the provisions of this CODE and all applicable local, state, territorial, federal, and tribal laws, as determined by the AHJ and to protect the health and SAFETY of the facility's BATHERS and PATRONS.

4.1.1.3 Approved Plans No person shall begin to construct a new AQUATIC FACILITY or shall SUBSTANTIALLY ALTER an existing AQUATIC FACILITY without first having the construction plans detailing the construction or SUBSTANTIAL ALTERATION submitted to and approved by the AHJ.

4.1.1.4 Plan Preparation All plans shall be prepared by a DESIGN PROFESSIONAL proficient in the application of this CODE and all applicable local, state, territorial, federal, and tribal laws relevant to the project and who shall apply this CODE and all applicable laws when preparing project plans.

4.1.1.5 Required Statements All construction plans shall include the following statements:

1) "The proposed aquatic facility and all equipment shall be constructed and installed in conformity with the approved plans and specifications or approved amendments," and
2) "No substantial alteration, changes, additions, or equipment not specified in the approved plans can be made or added until the plans for such substantial alteration, changes, additions, or equipment are submitted to and approved by the AHJ."

4.1.2 Content of Design Report

4.1.2.1 Basis of Design Report

4.1.2.1.1[A] Names / Addresses AQUATIC FACILITY plans shall include the name, address, and contact information for the owner, designer, and builder if available at the time of submission.

4.1.2.1.2 Site Information AQUATIC FACILITY plans shall include site information indicating at a minimum the location of all utilities, wells, topography, natural water features, and potential sources of surface drainage and pollution which have the potential to affect the proposed AQUATIC FACILITY.

4.1.2.1.3 Plot Plan AQUATIC FACILITY plans shall include a site plot plan including:

1) A general map and detailed scaled drawings of the AQUATIC FACILITY site plan or floor plan with detailed locations of the AQUATIC VENUES and AQUATIC FEATURES; and
2) The locations of all water supply facilities, sources of drinking water, public or private sewers, and relative elevations of paved or other walkways and the EQUIPMENT ROOM floor shall be shown on the plans with the elevations of storm and sanitary sewer inverts and street grade.

4.1.2.2 Plans and Specifications

4.1.2.2.1 Drawings Detailed scaled and dimensional drawings for each individual AQUATIC VENUE shall include an AQUATIC VENUE area plan and layout plan along with dimensioned longitudinal and transverse cross sections of the AQUATIC VENUE.

4.1.2.2.1.1 Operating Conditions The design documents shall include a record of operating conditions (water temperature(s), space temperature, space relative humidity, space dew point) and intended use for each type of VENUE (FLAT WATER, AGITATED WATER, HOT WATER) accepted by both the design engineer and owner/operator.

4.1.2.2.2 Aquatic Venue Attributes Detailed scaled and dimensional drawings for each individual AQUATIC VENUE shall include location and type of:

1) Inlets;
2) Overflows;
3) Drains;
4) Suction outlets;
5) Overflow gutters or devices;
6) Piping;
7) Designed pool waterline;
8) AQUATIC FEATURES such as ladders, stairs, diving boards, slides, and play features;
9) Lighting;
10) Pool markings; and
11) Surface materials

4.1.2.2.3 Area Design Detailed scaled and dimensional drawings of the AQUATIC FACILITY and for each individual AQUATIC VENUE, as appropriate, shall include location and type of:

1) Design of AQUATIC VENUE ENCLOSURE including walls, fencing, entry and exit doors and gates, self-closing and latching hardware, and locks;
2) Design of DECK, including paving materials, DECK slope, and DECK drains;
3) Paved walkways and other hardscape features;
4) SLIP-RESISTANT flooring;
5) AQUATIC VENUE area finishes;
6) Drinking fountains or other sources of drinking water;
7) Entries and exits;
8) Hose bibs;
9) Fences;
10) Telephones; and
11) Area lighting.

4.1.2.2.4 Aquatic Venue Recirculation and Treatment Design Detailed scaled and dimensional drawings for each individual AQUATIC VENUE shall contain a flow diagram showing the location, plan, elevation, and schematics of:

1) Filters;

2) Pumps;
3) Chemical feeders and interlocks;
4) Chemical controllers and interlocks;
5) SECONDARY TREATMENT, if required;
6) Supplemental disinfection systems, if installed;
7) Ventilation devices or AIR HANDLING SYSTEMS;
8) Heaters;
9) Surge tanks, including operating levels;
10) BACKPRESSURE prevention assemblies and air gaps;
11) Valves;
12) Piping;
13) Flow meters;
14) Gauges;
15) Thermometers;
16) Test cocks;
17) Sight glasses; and
18) Drainage system for the disposal of AQUATIC VENUE water and filter wastewater.

4.1.2.2.5 Equipment Room Design Detailed scaled and dimensional drawings for each individual AQUATIC VENUE shall contain a schematic layout of the AQUATIC VENUE EQUIPMENT ROOM OR AREA showing accessibility for installation and maintenance.

4.1.2.2.6 Chemical Storage Space Design Detailed scaled and dimensional drawings for each individual AQUATIC VENUE shall contain a schematic layout of the AQUATIC FACILITY CHEMICAL STORAGE SPACE(S).

4.1.2.2.7 Hygiene Facility Design Detailed scaled and dimensional drawings for each AQUATIC FACILITY shall show the location and number of all available HYGIENE FACILITIES provided including dressing rooms, lockers and basket STORAGE, SHOWERS, lavatory, toilet FIXTURES, and DIAPER-CHANGING STATIONS.

4.1.2.3 Technical Specifications

4.1.2.3.1[A] Accompanying Drawings Technical specifications for the construction of each AQUATIC VENUE and all appurtenances shall accompany the drawings for the AQUATIC FACILITY plans.

4.1.2.3.2[A] Technical Details The following technical specifications shall be provided for each AQUATIC FACILITY:

1) Water temperatures for each AQUATIC VENUE;
2) Effective surface area of each AQUATIC VENUE;
3) Space design:
    a. Listing of each room size (length, width, height).
    b. Statement that a vapor barrier is included in the construction of all interior and exterior wall and ceiling surfaces.

c. Statement that all windows are at least double pane and include a thermal break along with the U value, and

d. A listing of all wall and ceiling construction R values.

4) Design/desired dry bulb and dew point temperatures;

5) Design/desired relative humidity;

6) Type of water treatment; and

7) PERIMETER DECK and POOL DECK, which are the same as the WET DECK area defined in the ASHRAE 62.1.2019 Standard, which defines this area as the "area surrounding the POOL surface that is capable of being wetted during use or when POOL is occupied."

4.1.2.3.2.1 Details Not Shown on Plans Each AQUATIC VENUE shall include all construction details not shown on the plans that relate to the AQUATIC FACILITY:

4.1.2.3.2.2[A] Intended Use During the design of the ventilation and CLIMATE CONTROL SYSTEMS for INDOOR AQUATIC FACILITIES, the DESIGN PROFESSIONALS (engineers and architects) shall consult with and obtain input from the owner/operator to address intended uses, type of AQUATIC VENUES (FLAT WATER, AGITATED WATER, HOT WATER) and intended typical operating water temperatures, space air temperature, and relative humidity.

4.1.2.3.2.2.1 Design Criteria Document A design criteria document shall be written as a result of these consultations, signed by all parties involved and become a permanent document of the project specifications and owner's manual.

4.1.2.3.3 Water Sources The technical specifications for each AQUATIC FACILITY shall include the sources of all water supplies.

4.1.2.3.4 Area and Volume Technical specifications shall include the water surface area and volume of each AQUATIC VENUE and associated water features, if applicable.

4.1.2.3.5[A] Theoretical Peak Occupancy The technical specifications for each AQUATIC FACILITY and each AQUATIC VENUE shall include THEORETICAL PEAK OCCUPANCY, respectively.

4.1.2.3.5.1 Used for Designing Systems The THEORETICAL PEAK OCCUPANCY for ventilation air for an AQUATIC VENUE shall be used for designing systems that serve BATHERS and PATRONS.

4.1.2.3.5.2 Incorporate Non-Water Related Areas The THEORETICAL PEAK OCCUPANCY for an AQUATIC FACILITY shall be used for designing systems that serve BATHERS and PATRONS and shall incorporate non-water related areas such as DECKS and other adjacent portions of the AQUATIC FACILITY not associated with the AQUATIC VENUE.

4.1.2.3.5.3 Calculating Theoretical Peak Occupancy The THEORETICAL PEAK OCCUPANCY shall be calculated by dividing the surface area in square feet of the AQUATIC VENUE by the density factor (D) that fits the specific AQUATIC VENUE being considered.

THEORETICAL PEAK OCCUPANCY = AQUATIC VENUE Surface Area / D

The density factors (D) are Water/BATHER-related:

1) FLAT WATER density factor = 20 ft2 (1.9 m2) per BATHER.

2) AGITATED WATER density factor = 15 ft2 (1.4 m2) per BATHER.

3) HOT WATER density factor = 10 ft2 (0.9 m2) per BATHER.

4) WATERSLIDE LANDING POOL density factor = manufacturer-established capacity at any given time.

5) INTERACTIVE WATER PLAY water density factor = 10 ft2 (0.9 m2) per BATHER on surface.

6) SURF POOL density factor = manufacturer-established capacity at any given time.

Non-water/PATRON-related:

7) DECK density factor = 50 ft2 (4.6 m2) per BATHER.

8) STADIUM SEATING density factor = 6.6 ft2 (0.6 m2) per BATHER.

9) Diving Boards and Tall Platforms density factor = 300 ft2 (27.9 m2) per BATHER

4.1.2.3.5.3.1 Density Factor Modification The density factors may be modified to be higher values than listed in MAHC 4.1.2.3.5.3[A], so that more square footage is required per BATHER, but they shall not be modified to result in more BATHERS per square feet than listed for the factors in MAHC 4.1.2.3.5.3[A].

4.1.2.3.5.3.2 Aquatic Facility Theoretical Peak Occupancy The THEORETICAL PEAK OCCUPANCY for an AQUATIC FACILITY shall be determined by adding the calculations for each AQUATIC VENUE in the AQUATIC FACILITY.

4.1.2.3.6 Equipment Characteristics and Rating The technical specifications and supplemental engineering data for each AQUATIC FACILITY and each AQUATIC VENUE shall include:

1) Detailed information on the type, size, operating characteristics, and rating of all mechanical and electrical equipment;

2) Hydraulic computations for head loss in all piping and recirculation equipment;

3) Pump curves that demonstrate that the selected recirculation pump(s) are adequate for the calculated required flows; and

4) For INDOOR AQUATIC FACILITIES, documentation that demonstrates that the INDOOR AQUATIC FACILITY is designed to meet the acoustic design criteria contained in MAHC 4.6.11.

5) Documentation per MAHC 4.7.3.2.2.3 to demonstrate that the selected disinfectant feeders/equipment are of sufficient size and capacity, including evaluation of the CHLORINE demand factors in MAHC 4.7.3.2.2.2.1.

4.1.2.3.7 Recirculation Rate and Turnover The technical specifications for each AQUATIC VENUE shall include the recirculation rate and TURNOVER TIME.

4.1.2.3.8 Filter Media The technical specifications for each AQUATIC VENUE shall include information on the filter media such as diatomaceous earth, sand, gravel, or other approved material.

4.1.2.3.9 Equipment Specifications The technical specifications for each INDOOR AQUATIC FACILITY shall include information on each piece of equipment associated with that INDOOR AQUATIC FACILITY. For climate control equipment, the specifications shall include the following items at a minimum: sensible cooling capacity, sensible heating capacity, MOISTURE REMOVAL CAPACITY (MRC) in lbs/hr, MOISTURE REMOVAL EFFICIENCY (MRE) as listed in the AHRI Standard 920-2020 Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units or AHRI Standard 910-2014 Performance Rating of Indoor Pool Dehumidifiers, CFM of outside air, CFM of exhaust air, CFM of supply air, voltage, power requirements, and design temperature and humidity.

4.1.2.3.10 Safety Equipment Specifications The technical specifications for each AQUATIC FACILITY shall include information on all aquatic safety equipment.

4.1.2.3.11 Design for Risk Management The layout for zones of PATRON surveillance as specified in MAHC 6.3.3.1.1 shall be included and must show features or design configurations that can impact PATRON surveillance.

4.1.2.3.12 Other Specifications The technical specifications for each AQUATIC FACILITY and each AQUATIC VENUE shall include additional information related to the project requested by the AHJ for the purposes of the construction of the AQUATIC FACILITY and each AQUATIC VENUE and all appurtenances.

4.1.2.3.13 Air Filter Media The air filters used should be suitable for elevated humidity levels.

4.1.3[A] Plan Approval

4.1.3.1 New Construction

4.1.3.1.1 Approval Limitations The AHJ shall clearly state in its construction approval documents the limitations of their approval.

4.1.3.1.2 Other Approvals The approval shall also state that it is independent of all other required approvals such as building, zoning, fire, electrical, structural, and any other approvals as required by all applicable local, state, territorial, federal, and tribal laws and the applicant must separately obtain all other required approvals and permits.

4.1.3.1.3 Plan Review Coordination The AHJ shall coordinate their AQUATIC FACILITY plan review and communicate their approval with the owner's representative and DESIGN PROFESSIONALS associated with an AQUATIC FACILITY construction.

4.1.3.1.4 Plan Review Report The AHJ shall provide a plan submission compliance review list to the AQUATIC FACILITY owner with the following information:

1) Categorical items marked satisfactory, unsatisfactory, not applicable, or insufficient information;
2) A comment section, keyed to the compliance review list, shall detail unsatisfactory and insufficient findings;
3) Indication of the AHJ approval or disapproval of the AQUATIC FACILITY construction plans;
4) In the case of a disapproval, specific reasons for disapproval, and procedure for resubmittal; and
5) Reviewer's name, signature, and date of review.

4.1.3.1.5 Plans Maintained The AQUATIC FACILITY owner shall maintain at least one set of their own approved plans made available to AHJ on file for as long as the AQUATIC FACILITY is in operation.

4.1.3.2 Non-Substantial Alterations

4.1.3.2.1 Alteration Review The AQUATIC FACILITY owner planning a NON-SUBSTANTIAL ALTERATION shall contact the AHJ to review proposed changes prior to starting the NON-SUBSTANTIAL ALTERATION.

4.1.3.2.2 Alteration Scope The AQUATIC FACILITY operator shall consult with the AHJ to determine if new or modified plans must be submitted for plan review and approval for other NON-SUBSTANTIAL ALTERATIONS proposed.

4.1.3.3[A] Replacements

4.1.3.3.1 Replacement Approval Prior to replacing equipment, the AQUATIC FACILITY owner shall submit technical verification to the AHJ that all replacement equipment is equal to that which was originally approved and installed.

4.1.3.3.2 Replacement Equipment Equivalency The replacement of pumps, filters, feeders, controllers, SKIMMERS, flow-meters, valves, or other similar equipment with identical or substantially similar equipment may be done without submission to the AHJ for approval of new or altered AQUATIC FACILITY plans.

4.1.3.3.3 Emergency Replacement In emergencies, the replacement may be made prior to receiving the AHJ's approval, with the owner accepting responsibility for proper immediate replacement, if the equipment is not deemed equivalent by the AHJ.

4.1.3.3.3.1 Documentation Where emergency replacements are installed as per MAHC 4.1.3.3.3, the owner shall submit documentation for review and approval of the replacement to the AHJ within 45 days.

4.1.3.3.4 Replacement Record Maintenance The AHJ shall provide the AQUATIC FACILITY owner written approval or disapproval of the proposed replacement equipment's equivalency.

4.1.3.3.5 Documentation Documentation of proposed, approved, and disapproved replacements shall be maintained in the AHJ's AQUATIC FACILITY files.

4.1.4[A] Compliance Certificate

4.1.4.1 Construction Compliance Certificate A certificate of construction compliance shall be submitted to the AHJ for all AQUATIC FACILITY plans for new construction and SUBSTANTIAL ALTERATIONS requiring AHJ approvals.

4.1.4.2 Certificate Preparation This certificate shall be prepared by a DESIGN PROFESSIONAL and be within the scope of their practice as defined by the local, state, territorial, federal, and tribal laws governing professional practice within the jurisdiction of the construction permit-issuing official.

4.1.4.3 Certificate Statement The certificate shall also include a statement that the AQUATIC FACILITY, all equipment, and appurtenances have been constructed and/or installed in accordance with approved plans and specifications.

4.1.4.4[A] Systems Commissioning If commissioning or testing reports for systems such as AQUATIC FACILITY lighting, air handling, recirculation, filtration, and/or DISINFECTION are conducted, then those reports shall be included in furnished documentation.

4.1.4.5 Maintenance Documentation of AQUATIC FACILITY new construction or SUBSTANTIAL ALTERATION plan compliance shall be maintained in the AHJ's AQUATIC FACILITY files.

4.1.5 Construction Permits

4.1.5.1 Construction Permits for Building Applicable construction permits shall be obtained before any AQUATIC FACILITY may be constructed.

4.1.5.2 Construction Permit for Remodeling A construction permit or other applicable permits may be required from the AHJ before SUBSTANTIAL ALTERATION of an AQUATIC FACILITY.

4.1.5.3 Issuance The AHJ shall issue a construction permit to the owner:

1) After receiving a certificate of completion from the DESIGN PROFESSIONAL verifying information submitted and
2) When new construction, SUBSTANTIAL ALTERATIONS, or annual renewal requirements of this CODE have been met.

4.1.5.4 Denial The construction permit (license) may be denied or withheld, suspended or revoked by the AHJ for noncompliance of the AQUATIC FACILITY with the requirements of this CODE, and the owner will be provided:

1) Specific reasons for disapproval and procedure for resubmittal;
2) Notice of the rights to appeal this denial and procedures for requesting an appeal; and

3) Reviewer's name, signature, and date of review and denial.

4.1.5.5 Documentation Documentation of AQUATIC FACILITY construction permit renewal or denial shall be maintained in the AHJ's AQUATIC FACILITY files.

4.1.5.6 Suspension or Revocation The AHJ shall revoke a construction permit or approval issued under the provisions of this CODE in case of any false statement or misrepresentation of fact in the application or on the construction documents on which the approval was based.

4.1.5.7 Stop Work Orders Upon notice from the AHJ, work on any system that is being performed contrary to the provisions of this CODE or in a dangerous or unsafe manner shall immediately cease. Such notice shall be in writing and shall be given to the owner of the property, the owner's authorized agent, or to the person performing the work. The notice shall state the condition under which work is authorized to resume.

4.1.5.7.1 Emergency Stop Work Orders When an emergency exists, the AHJ shall not be required to give a written notice prior to stopping the work.

4.2 Materials

4.2.1 Aquatic Venues

4.2.1.1 Construction Material AQUATIC VENUES shall be constructed of reinforced concrete or impervious and structurally sound material(s), which provide a smooth, easily cleaned, watertight structure capable of withstanding the anticipated stresses/loads for full and empty conditions taking into consideration climatic, hydrostatic, seismic, and the integration of the AQUATIC VENUE with other structural conditions and as required by applicable CODES.

4.2.1.2 Durability All materials shall be inert, non-toxic, resistant to corrosion, impervious, enduring, and resistant to damages related to environmental conditions of the installation region.

4.2.1.3 Areas Subject to Freezing Where located in areas subject to freezing, AQUATIC VENUES and appurtenances shall be designed to protect against damage due to freezing.

4.2.1.4 Competitive Pools Competitive or lap POOLS may have lane markings and end wall targets installed in accordance with World Aquatics, NCAA, USA Swimming, NFHS, or other recognized STANDARD.

4.2.1.5[A] Design Parameters Any graphics, color, or finish incorporated into the construction of a POOL or painted on the floor or walls shall not prevent the detection of a BATHER in distress, algae, sediment, or other objects in the AQUATIC VENUE.

4.2.1.6 Watertight POOLS shall be designed in such a way to maintain their ability to retain the designed amount of water.

4.2.1.7[A] Smooth Finish All vertical walls shall have a durable finish suitable for regular scrubbing and cleaning at the waterline.

4.2.1.7.1 Daily Cleaning The finish shall be able to withstand daily brushing, scrubbing, and cleaning of the surface in accordance with the manufacturer's recommendations.

4.2.1.7.2 Skimmer Pools SKIMMER POOLS shall have a 6 inch (152 mm) to 12 inch (305 mm) high waterline finish that meets the requirements of MAHC 4.2.1.7 and 4.2.1.7.1.

4.2.1.7.3 Gutter / Perimeter Overflow Systems Gutter or perimeter overflow systems shall have a minimum finish height of 2 inches (51 mm) that meets the requirements of MAHC 4.2.1.7 and 4.2.1.7.1.

4.2.1.7.4 Dark Colors If dark colors in excess of what is required in MAHC 4.5.11 of this CODE are used for the POOL finish, these colors shall not extend more than 12 inches (305 mm) below the waterline.

4.2.1.8[A] Slip Resistant POOL floors in areas less than 3 feet (0.9 m) deep shall have a SLIP-RESISTANT finish.

4.2.1.9 Stainless Steel, Vinyl, PVC-P or PVC Pools Stainless steel, vinyl, PVC-P, or PVC panel and liner POOL finish systems shall be acceptable provided that the system is installed on top of approved materials and design requirements as listed within this section.

4.2.1.9.1 Damaged If at any time the liner system is damaged or cut in such a way that its integrity is compromised, the POOL shall be shut down until the system is fully repaired.

4.2.1.10 Not Permitted Wood, sand, or earth shall not be permitted as an interior finish.

4.2.2 Indoor Aquatic Facility

4.2.2.1 Interior Finish

4.2.2.1.1 Relative Humidity The interior finish of an INDOOR AQUATIC FACILITY shall be designed for an indoor relative humidity as not less than 80%.

4.2.2.2[A] Condensation Prevention

4.2.2.2.1[A] Cold Weather INDOOR AQUATIC FACILITY building envelope construction shall include a vapor-retarder/insulation arrangement to assist in preventing the condensation of water on inside POOL room envelope building surfaces and within any wall, ceiling, glass, or floor structure under the coldest outdoor conditions based on the ASHRAE climate data for the project locale or nearest reporting city and the highest design indoor relative humidity.

4.2.2.2.1.1 Weather Data The ASHRAE dehumidification weather data for the FACILITY geographical location shall be used when calculating the effects of the ventilation air to the space it is being introduced. This shall be added to the evaporation load of all water surfaces, and occupant (includes spectators, swimmers, and non-swimmers on the DECK) latent moisture when sizing the climate control equipment.

4.2.2.2.2[A] Paint or Coating Where a paint or coating serves as the vapor retarder of an INDOOR AQUATIC FACILITY, the paint or coating shall be applied so as to produce a permeability rating of 0.2 U.S. perm (11.4 ng·s−1·m−2·Pa−1) or less. All paints and coatings applied inside the air barrier of a facility shall meet the requirements of UL 2818-2013 through testing of products to CDPH/EHLB/Standard Method v1.1 or UL 2818-2013.

4.2.2.2.2.1 Application The paint or coating shall be applied according to the manufacturer's recommendations for use as a vapor retarder.

4.2.2.2.3 Perforated Interior-Finish Material Where a perforated interior-finish material is used in an INDOOR AQUATIC FACILITY, as for acoustic effects, the perforated material shall not be considered to be a vapor retarder unless it has a listed permeability rating less than 0.2 U.S. perm (11.4 ng·s−1·m−2·Pa−1).

4.2.2.3 Mechanical Systems

4.2.2.3.1 Equipment Rooms For EQUIPMENT ROOMS, see MAHC 4.9.1.

4.2.2.3.2 Chemical Storage Spaces For chemical storage spaces, see MAHC 4.9.2.

4.2.2.3.3[A] Indoor Aquatic Facility Air Pressure INDOOR AQUATIC FACILITY air pressure shall be relative to the areas external to it (such as adjacent indoor spaces or adjacent outdoor spaces.) The AQUATIC FACILITY AIR HANDLING SYSTEM design, construction, and installation shall comply with the ASHRAE 2019 negative pressure recommendations as outlined in the ASHRAE Applications Handbook on Indoor Pool

Design and the ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality, and all applicable local, state, territorial, federal, and tribal laws and additional requirements as stated in section MAHC 4.6.2.

4.2.2.3.3.1 Chemical Storage Space Air Pressure AIR HANDLING SYSTEM design for CHEMICAL STORAGE SPACES shall conform to the International Mechanical Code or Uniform Mechanical Code, and either the International Fire Code or the NFPA 1 Fire Code, and all applicable local, state, territorial, federal, and tribal laws.

4.2.2.3.3.1.1 Not Interconnected This CHEMICAL STORAGE SPACE AIR HANDLING SYSTEM shall not be interconnected with the INDOOR AQUATIC FACILITY'S CLIMATE CONTROL SYSTEM.

4.2.2.3.4[A] Air Ducts Where air ducts are required, they shall be resistant to corrosion from the airborne chemicals.

4.2.2.3.4.1[A] Insulated Duct Any system duct work located in an area not being conditioned shall be insulated on the exterior of the duct with a mold-resistant material where the surface temperature of the duct is capable of being less than the airstream temperature within the duct.

4.2.2.3.5 Filters Filters for outdoor-air intake shall be rated moisture resistant.

4.2.2.4[A] Indoor Aquatic Facility Doors

4.2.2.4.1 Corrosion Resistant INDOOR AQUATIC FACILITY doors shall either be constructed of corrosion-resistant materials or have a covering or coating to withstand humid and corrosive environments which is acceptable to the AHJ.

4.2.2.4.2 Uncontrolled Condensation INDOOR AQUATIC FACILITY doors which may be exposed to temperatures below INDOOR AQUATIC FACILITY-air dew point shall have thermal breaks, insulation, and/or glazing as necessary to minimize the risk of uncontrolled condensation.

4.2.2.4.2.1 Heating Systems Exception Other doors shall be acceptable, subject to approval by the AHJ, where heating systems are so arranged as to maintain such doors above the maximum design dew point of the INDOOR AQUATIC FACILITY air.

4.2.2.4.3 Biological Contaminants INDOOR AQUATIC FACILITY doors and door-frame construction shall not contribute to the growth of biological CONTAMINANTS.

4.2.2.4.4 Air Leakage INDOOR AQUATIC FACILITY doors and/or door frames shall be equipped with seals and/or gaskets to minimize air leakage when the door is closed.

4.2.2.4.5[A] Automatic Door Closer All pedestrian doors around the INDOOR AQUATIC FACILITY perimeter shall be equipped with an automatic door closer capable of closing the door completely without human assistance and a self-latching device designed to engage and keep the door closed without human assistance.

4.2.2.4.5.1 Difference in Air Pressure Door closers shall be able to close the door against the specified difference in air pressure between the INDOOR AQUATIC FACILITY and other INTERIOR SPACES.

4.2.2.5[A] Indoor Aquatic Facility Windows

4.2.2.5.1 Frames INDOOR AQUATIC FACILITY window frames shall be constructed of suitable materials or shall have a suitable covering or coating to withstand the expected atmosphere.

4.2.2.5.2 Biological Contaminants INDOOR AQUATIC FACILITY window frames shall be constructed of materials that do not contribute to the growth of biological CONTAMINANTS.

4.2.2.5.3 Thermal Breaks INDOOR AQUATIC FACILITY window frames shall have thermal breaks or be otherwise constructed to minimize the risk of uncontrolled condensation.

4.2.2.6 Indoor Aquatic Facility Electrical Systems and Components Refer to MAHC 4.6.3

4.3 Equipment Standards

4.3.1 Accredited Standards Where applicable, all equipment used or proposed for use in AQUATIC FACILITIES governed under this CODE shall be:

1) Of a proven design and construction and

2) CERTIFIED, LISTED, AND LABELED to a specific STANDARD for the specified equipment use by an ANSI- accredited certification organization.

4.3.2 No Standards Where STANDARDS do not exist, technical documentation shall be submitted to the AHJ to demonstrate acceptability for use in AQUATIC FACILITIES.

4.3.3 Suitable for Intent All equipment and materials used or proposed for use in AQUATIC FACILITIES shall be suitable for their intended use and be installed in accordance with this CODE, as CERTIFIED, LISTED, AND LABELED to a specific STANDARD by an ANSI-accredited certification organization where applicable, and as specified by the manufacturer.

4.3.3.1 Proof of Acceptability The AHJ shall have the authority to require tests, as proof of acceptability.

4.4 Aquatic Facility and Venue Operation and Maintenance [N/A]

4.5 Aquatic Venue Structure

4.5.1[A] Design for Risk Management Design of AQUATIC FACILITIES and/or AQUATIC VENUE(s) shall include consultation with and input by the owner and/or an aquatic risk management consultant and address operational considerations such as the layout of zones of PATRON surveillance.

4.5.1.1 Basic Requirements The AQUATIC VENUE shape shall provide for the SAFETY of swimmers, the thorough and complete circulation of the water, the ability to clean and maintain the AQUATIC VENUE, and be considered when planning for effective supervision and surveillance of BATHERS and PATRONS using the AQUATIC VENUE.

4.5.1.2 Water Clarity Main suction outlets or a permanent tile used as a reference to test for or observe water clarity shall be installed according to MAHC 4.5.1.2.1 through 4.5.1.2.4.

4.5.1.2.1 Pools Ten Feet Deep or Less For POOLS 10 feet deep (3.0 m) or less, a 4 inch x 4 inch square (10.2 cm x 10.2 cm) reference tile in a contrasting color to the POOL floor or main suction outlet shall be located at the deepest part of the POOL.

4.5.1.2.2 Pools Over Ten Feet Deep For POOLS over 10 feet deep (3.0 m) an 8 inch by 8 inch square (20.3 cm x 20.3 cm) reference tile in a contrasting color to the POOL floor or main suction outlet shall be located at the deepest part of the POOL.

4.5.1.2.3 Visible This reference tile shall be visible at all times at any point on the DECK up to 30 feet (9.1 m) away in a direct line of sight from the tile or main drain.

4.5.1.2.4 Spas For SPAS, this test shall be performed when the water is in a non-turbulent state and bubbles have been allowed to dissipate.

4.5.1.2.5 Reference Tile Alternative Where main suction outlets are not provided for or where finish materials do not allow for the installation of a water clarity reference tile, an alternate means of achieving the goal of observing water clarity shall be provided.

4.5.1.2.6 General Construction Tolerances The AQUATIC VENUE structure shall not exceed the tolerances in MAHC table 4.5.1.2.6.

4.5.1.2.7 Exceptions Where the AQUATIC VENUE is intended for competition, the general construction tolerances shall not exceed design standards in accordance with World Aquatics, NCAA, USA Swimming, USA Diving, USA Water Polo, NFHS, or other recognized standard for the intended competition.

Table 4.5.1.2.6: General Construction Tolerances

Design Aspect	Construction Tolerance
Depth deep area, including diving area	+ 3 inches
Depth shallow area	+2 inches
Length – overall	+3 inches
Stair Treads	+1/2 inches
Stair Risers	See MAHC 4.5.4.6
Wall Slopes	See MAHC 4.5.12.1
Skimmers	See MAHC 4.7.1.5.5.1
Gutters	See MAHC 4.7.1.4.5A
Width – overall	+3 inches
All dimensions not specified therein	+2 inches

4.5.2 Bottom Slope

4.5.2.1[A] Under Five Feet In water depths under 5 feet (1.5 m), the slope of the floor of all POOLS shall not exceed 1 foot (30.5 cm) vertical drop for every 12 feet (3.7 m) horizontal.

4.5.2.2 Five Feet or Over In water depths 5 feet (1.5 m) and greater, the slope of the floors of all POOLS shall not exceed 1 foot (30.5 cm) vertical to 3 feet (0.9 m) horizontal.

Exception: POOLS designed and used for competitive diving shall be designed to meet the STANDARDS of the sanctioning organization (such as NFHS, NCAA, USA Diving, or World Aquatics).

4.5.2.3[A] Drain POOLS shall be designed so that they drain without leaving puddles or trapped standing water.

4.5.3 Pool Access / Egress

4.5.3.1[A] Accessibility Each POOL shall have a minimum of two means of access and egress, with one located within 10 feet (3.0 m) of the shallowest end, and one located within 10 feet of the deepest end of the POOL, where applicable, with the exception of:

1) Waterslide landing pools,
2) Waterslide runouts, and
3) Wave pools.

4.5.3.2 Acceptable Means Acceptable means of access / egress shall include stairs / handrails, grab rails / RECESSED STEPS, ladders, ramps, and zero-depth entries.

4.5.3.3 Large Venues For POOLS wider than 30 feet (9.1 m), such means of access / egress shall be provided on each side of the POOL.

4.5.3.3.1 Distance Apart For POOLS wider than 30 feet (9.1 m), such means of access / egress shall not be more than 75 feet (22.9 m) apart.

4.5.4 Stairs

4.5.4.1 Slip Resistant Where provided, stairs shall be constructed with SLIP-RESISTANT materials.

4.5.4.2 Outlined Edges The leading horizontal and vertical edges of stair treads shall be outlined with a continuous SLIP-RESISTANT, contrasting tile or other permanent marking of not less than 1 inch (25.4 mm) and not greater than 2 inches (50.8 mm).

4.5.4.3[A] Deep Water Where stairs are provided in POOL water depths greater than 5 feet (1.5 m), they shall be recessed and not protrude into the swimming area of the POOL.

4.5.4.3.1 Lowest Tread Where stairs are provided in POOL water depths greater than 5 feet (1.5 m), the lowest tread shall be not less than 4 feet (1.2 m) below normal water elevation.

4.5.4.4 Stairs Stairs shall have a minimum uniform horizontal tread depth of 12 inches (30.5 cm), and a minimum unobstructed tread width of 24 inches (61.0 cm).

4.5.4.5 Dimensions Dimensions of stair treads for other types of stairs shall conform to requirements of:

1) MAHC Table 4.5.4.5,
2) MAHC Figure 4.5.4.5.1, and
3) MAHC Figure 4.5.4.5.2

Table 4.5.4.5: Required Dimensions for Stair Treads and Risers

Dimensions	T-1 Standard	T-2	W-1	H-1
Minimum	12 inches (30.5 cm)	T-1	24 inches (61.0 cm)	6 inches (15.2 cm)
Maximum	18 inches (45.7 cm)	T-1	N/A	12 inches (30.5 cm)

Figure 4.5.4.5.1: Stair Treads and Risers: Side View

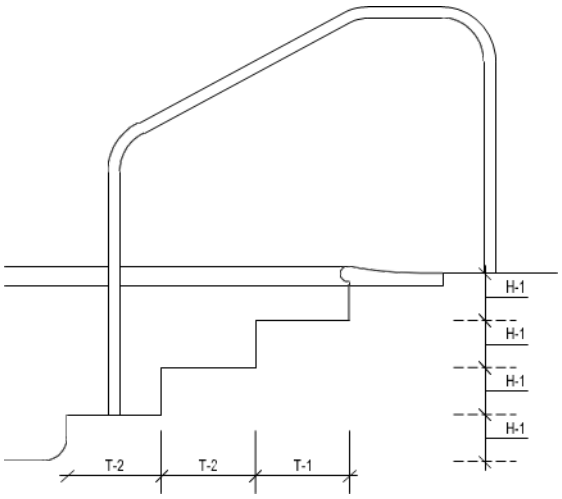
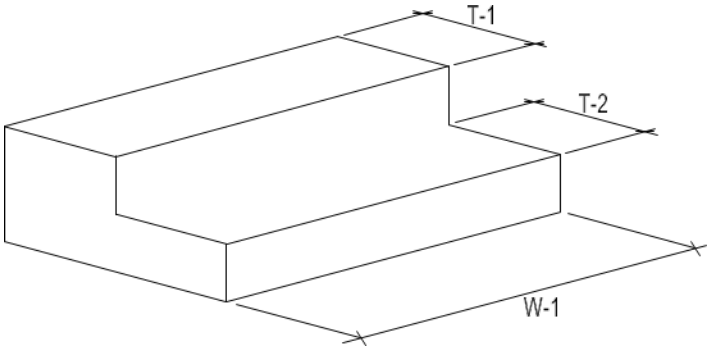


Figure 4.5.4.5.2: Stair Treads: Front View



4.5.4.6 Stair Risers Stair risers shall have a minimum uniform height of 6 inches (15.2 cm) and a maximum height of 12 inches (30.5 cm), with a tolerance of ½ inches (12.7 mm) between adjacent risers.

4.5.4.6.1 Transitional Areas Stairs shall not be used underwater to transition between two sections of POOL of different depths. The bottom riser may vary due to potential cross slopes with the POOL floor; however, the bottom step riser may not exceed the maximum allowable height required by this section.

4.5.4.7 Top Surface The top surface of the uppermost stair tread shall be located not more than 12 inches (30.5 cm) below the POOL coping or DECK.

4.5.4.8[A] Perimeter Gutter Systems For POOLS with PERIMETER GUTTER SYSTEMS, the gutter may serve as a step, provided that the gutter is provided with a grating or cover and conforms to all construction and dimensional requirements herein specified.

4.5.5 Handrails

4.5.5.1 Provided Handrail(s) shall be provided for each set of stairs.

4.5.5.2 Corrosion Resistant Handrails shall be constructed of corrosion-resistant materials and anchored securely.

4.5.5.3[A] Upper Railing The upper railing surface of handrails shall extend above the POOL coping or DECK a minimum of 28 inches (71.1 cm).

4.5.5.4 Wider Than Five Feet Stairs wider than 5 feet (1.5 m) shall have handrails at either side and spaced not more than every 12 feet (3.7 m) apart across the entire stair width.

4.5.5.5[A] ADAAG Accessibility Handrail outside dimensions intended to serve as a means of ADAAG accessibility shall conform to requirements of MAHC 4.5.5.6.

4.5.5.6 Support Handrails shall be designed to resist a load of 50 pounds (22.7 kg) per linear foot applied in any direction and independently a single concentrated load of 200 pounds (90.7 kg) applied in any direction at any location.

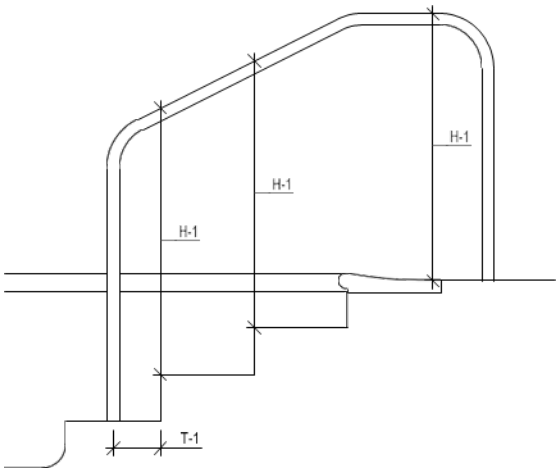
4.5.5.6.1 Transfer Loads Handrails shall be designed to transfer these loads through the supports to the POOL or DECK structure.

4.5.5.7[A] Dimensions Dimensions of handrails shall conform to requirements of MAHC Table 4.5.5.7 and MAHC Figure 4.5.5.7.1.

Table 4.5.5.7: Stair Handrail Dimensions

Dimensions	T-1	H-1
Minimum	3 inches (7.6 cm)	34 inches (86.4 cm)
Maximum	N/A	38 inches (96.5 cm)

Figure 4.5.5.7.1: Stair Handrails: Side View



4.5.6 Grab Rails

4.5.6.1 Corrosion Resistant Where grab rails are provided, they shall be constructed of corrosion- resistant materials.

4.5.6.2 Anchored Grab rails shall be anchored securely.

4.5.6.3 Provided Grab rails shall be provided at both sides of RECESSED STEPS.

4.5.6.4 Clear Space The horizontal clear space between grab rails shall be not less than 18 inches (45.7 cm) and not more than 24 inches (61.0 cm).

4.5.6.5 Upper Railing The upper railing surface of grab rails shall extend above the POOL coping or DECK a minimum of 28 inches (71.1 cm).

4.5.6.6 Support Grab rails shall be designed to resist a load of 50 pounds (22.7 kg) per linear foot applied in any direction and independently a single concentrated load of 200 pounds (90.7 kg) applied in any direction at any location.

4.5.6.6.1 ***Transfer Loads*** Grab rails shall be designed to transfer these loads through the supports to the POOL or DECK structure.

4.5.7 Recessed Steps

4.5.7.1 Slip Resistant Recessed steps shall be SLIP RESISTANT.

4.5.7.2 Easily Cleaned RECESSED STEPS shall be designed to be easily cleaned.

4.5.7.3 Drain RECESSED STEPS shall drain into the POOL.

4.5.7.4 Dimensions Dimensions of RECESSED STEPS shall conform to requirements of:

1) MAHC Table 4.5.7.4,
2) MAHC Figure 4.5.7.4.1, and
3) MAHC Figure 4.5.7.4.2.

Table 4.5.7.4: Recessed Step Dimensions

Dimensions	H-1	H-2	W-1	D-1	D-2
Minimum	6 inches (15.2 cm)	5 inches (12.7 cm)	12 inches (30.5 cm)	5 inches (12.7 cm)	N/A
Maximum	12 inches (30.5 cm)	N/A	N/A	N/A	2.5 inches (6.5 cm)

Figure 4.5.7.4.1: Recessed Step Dimensions: Side View

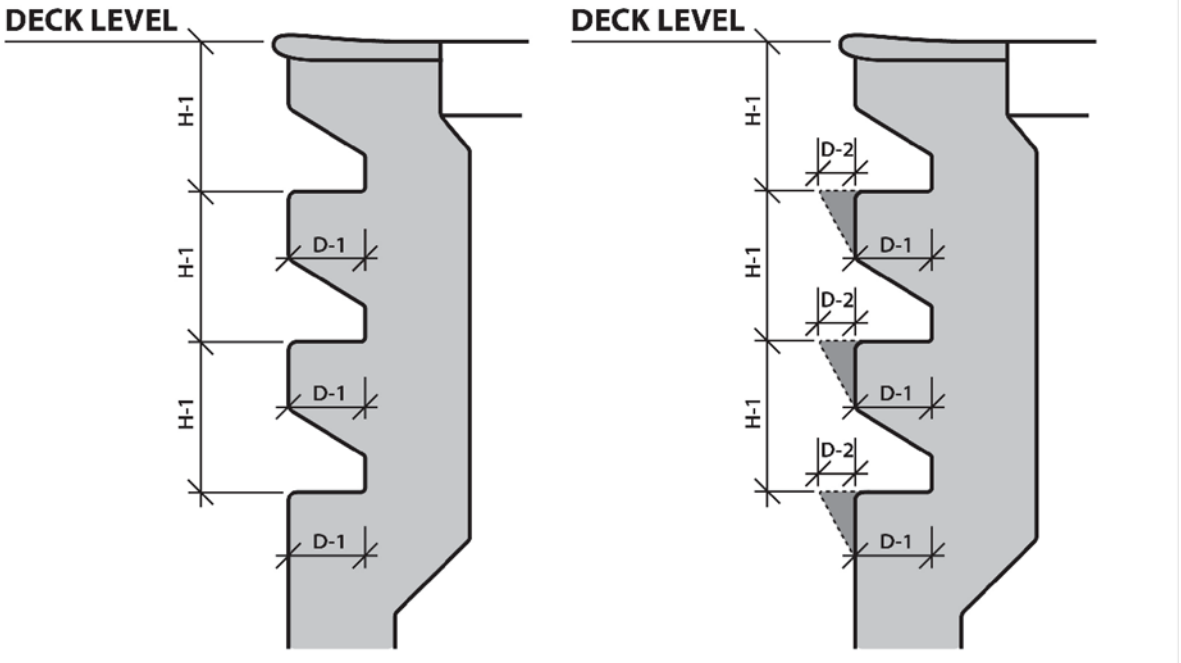
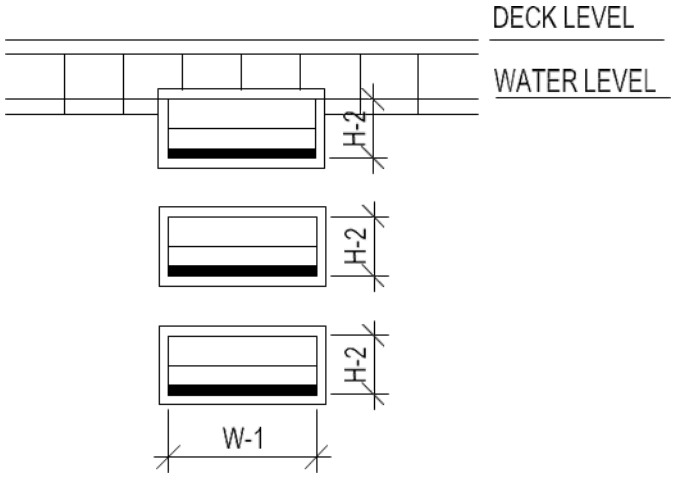


Figure 4.5.7.4.2: Recessed Step Dimensions: Front View



4.5.7.5 Uniformly Spaced RECESSED STEPS shall be uniformly spaced not less than 6 inches (15.2 cm) and not more than 12 inches (30.5 cm) vertically along the POOL wall.

4.5.7.6 Uppermost Step The top surface of the uppermost RECESSED STEP shall be located not more than 12 inches (30.5 cm) below the POOL coping or DECK.

4.5.7.7 Perimeter Gutter Systems For POOLS with PERIMETER GUTTER SYSTEMS, the gutter may serve as a step, provided that the gutter is provided with a grating or cover and conforms to all construction and dimensional requirements herein specified.

4.5.8 Ladders

4.5.8.1 General Guidance for Ladders

4.5.8.1.1 Corrosion Resistant Where provided, ladders shall be constructed of corrosion-resistant materials.

4.5.8.1.2 Anchored Ladders shall be anchored securely to the DECK.

4.5.8.2[A] Ladder Handrails

4.5.8.2.1 Two Handrails Provided Ladders shall have two handrails.

4.5.8.2.2 Clear Space The horizontal clear space between handrails shall be not less than 17 inches (43.2 cm) and not more than 24 inches (61.0 cm).

4.5.8.2.3 Upper Railing The upper railing surface of handrails shall extend above the POOL coping or DECK a minimum of 28 inches (71.7 cm).

4.5.8.2.4[A] Pool Wall The clear space between handrails and the POOL wall shall be not less than 3 inches (7.6 cm) and not more than 4 inches (10.2 cm) between the POOL wall and the ladder.

4.5.8.2.5[A] Support Ladders shall be designed to resist a load of 50 pounds (22.7 kg) per linear foot applied in any direction and independently a single concentrated load of 200 pounds (90.7 kg) applied in any direction at any location.

4.5.8.2.5.1 Transfer Loads Ladders shall be designed to transfer these loads through the supports to the POOL or DECK structure.

4.5.8.3 Ladder Treads

4.5.8.3.1 Slip Resistant Ladder treads shall be SLIP RESISTANT.

4.5.8.3.2 ***Tread Depth*** Ladder treads shall have a minimum horizontal tread depth of 1.5 inches (3.8 cm).

4.5.8.3.2.1 Distance Between Tread and Pool Wall The distance between the horizontal tread and the POOL wall shall not be greater than 4 inches (10.2 cm).

4.5.8.3.3 ***Uniformly Spaced*** Ladder treads shall be uniformly spaced not less than 7 inches (17.8 cm) and not more than 12 inches (30.5 cm) vertically at the handrails.

4.5.8.3.4 ***Upmost Ladder Tread*** The top surface of the upmost ladder tread shall be located not more than 12 inches (30.5 cm) below the POOL coping, gutter, or DECK.

4.5.9 Zero Depth (Sloped) Entries

4.5.9.1 Slip Resistant Where ZERO DEPTH ENTRIES are provided, they shall be constructed with SLIP- RESISTANT materials.

4.5.9.2 Maximum Floor Slope ZERO DEPTH ENTRIES shall have a maximum floor slope of 1:12, consistent with the requirements of MAHC 4.5.2.1.

4.5.9.2.1 ***Slope Changes*** Changes in floor slope shall be permitted.

4.5.9.3 Trench Drains Trench drains shall be used along ZERO DEPTH ENTRIES at the waterline to facilitate surface skimming.

4.5.9.3.1 ***Flat or Follow Slope*** The trenches may be flat or follow the slope of the ZERO DEPTH ENTRY.

4.5.9.3.2 ***Handholds*** Any handholds that present a trip hazard shall not be continuous along the ZERO DEPTH ENTRY.

4.5.9.4 Rope and Float Line Where the bottom of a POOL slopes from a ZERO DEPTH ENTRY to water depths greater than 3 feet (0.9 m) and includes an area for young non-swimmers to wade and play, a ROPE AND FLOAT LINE shall be installed at the 3 feet (0.9 m) depth to provide a visual and physical separation between the area for toddlers and young non-swimmers and the deeper areas of the POOL.

4.5.9.4.1 ***Exceptions*** An exception shall be made for WAVE POOLS, SURF POOLS, and WATERSLIDE LANDING POOLS.

4.5.10 Disabled Access

4.5.10.1[A] Conform to ADA Standards Access for disabled persons shall conform to ADA STANDARDS as approved by the Department of Justice.

4.5.10.2 Pool Lifts All POOL lifts shall be CERTIFIED, LISTED, AND LABELED in accordance with UL 60335-2-1000, and be installed and used in accordance with the manufacturer's installation instructions and ICC/ANSI A117.1.

4.5.11 Color and Finish

4.5.11.1[A] White or Light Pastel Floors and walls below the water line shall be white or light pastel in color such that from the POOL DECK a BATHER is visible on the POOL floor and the following items can be identified:

1) Algae growth, debris, or dirt within the POOL;
2) CRACKS in the surface finish of the POOL; and
3) Reference tiles defined in MAHC 4.5.1.2.

4.5.11.1.1[A] ***Munsell Color Value*** The finish shall be at least 6.5 on the Munsell color value scale.

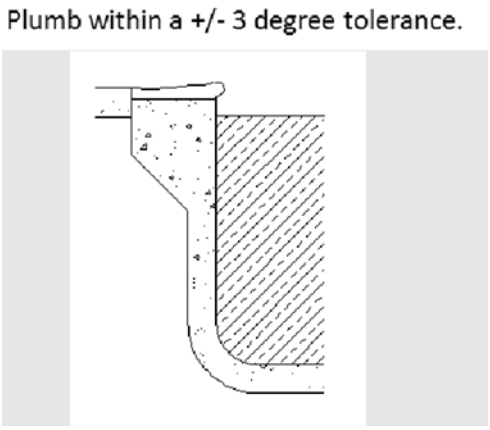
4.5.11.1.2 Exceptions An exception shall be made for the following AQUATIC VENUE components:

1) Competitive lane markings,
2) Dedicated competitive diving well floors,
3) Step or bench edge markings,
4) POOLS shallower than 24 inches (61.0 cm),
5) Water line tiles, or
6) WAVE POOL and SURF POOL depth change indicator tiles.

4.5.12 Walls

4.5.12.1 Plumb POOL walls shall be plumb within a +/- 3 degree tolerance to a water depth of at least 5 feet (1.5 m) unless the wall design requires structural support ledges and slopes below to support the upper wall. Refer to MAHC Figure 4.5.12.1.

Figure 4.5.12.1: Plumb Pool Walls: Cross-Section



4.5.12.2 Contrasting Color A contrasting color shall be provided on the edges of any support ledge to draw attention to the ledge for BATHER SAFETY.

4.5.12.3 Rounded Corners All corners created by adjoining walls shall be rounded or have a radius in both the vertical and horizontal dimensions to eliminate sharp corners.

4.5.12.4[A] No Protrusions, Extensions, Means of Entanglement, or Obstructions There shall be no protrusions, extension, means of entanglement, or other obstructions in the AQUATIC VENUE that may cause the entrapment or injury of the user or interfere with proper POOL operation.

4.5.12.5 Transitional Point Where walls join the floor, the transitional point or profile shall comply with the following:

4.5.12.5.1 Intersect Walls may intersect with the floor at an angle or a transition profile.

4.5.12.5.2 Depths 3–5 Feet At water depths 3–5 ft (91–152 cm), the maximum radius shall be 2 ft 3 in (69 cm).

4.5.12.5.3 Depths Less Than Three Feet At water depths 3 ft (91 cm) or less, a transitional radius shall not exceed 6 in (15 cm) and shall be tangent to the wall and may be tangent to or intersecting the floor.

4.5.12.5.4 Depths Greater Than Three Feet At water depths greater than 3 ft (91 cm), a transitional radius shall be tangent to the wall at a point no less than 2 ft 6 in (76 cm) below the water surface

and may progressively increase from 6 in (15 cm) to a value capable of being tangent to or intersecting the floor.

4.5.13[A] Structural Stability

4.5.13.1 Withstand Loads POOLS shall be designed to withstand the reasonably anticipated loads imposed by POOL water, BATHERS, and adjacent soils or structures.

4.5.13.2 Hydrostatic Relief Valve A hydrostatic relief valve and/or suitable under drain system shall be provided where the water table exerts hydrostatic pressure to uplift the POOL when empty or drained.

4.5.13.3 Freezing POOLS and related circulation piping shall be designed with a winterizing strategy when in an area subject to freeze/thaw cycles.

4.5.14[A] Handholds

4.5.14.1 Handholds Provided Where not otherwise exempted, every POOL shall be provided with handholds (PERIMETER GUTTER SYSTEM, coping, horizontal bars, recessed handholds, cantilevered DECKING) around the perimeter of the POOL and at WING WALLS or PENINSULAS where the water depth at the wall exceeds 24 inches (61.0 cm).

4.5.14.1.1 Installed These handholds shall be installed not greater than 9 inches (22.9 cm) above, or 3 inches (7.6 cm) below static water level.

4.5.14.2 Horizontal Recesses Horizontal recesses may be used for handholds provided they are a minimum of 24 inches (61.0 cm) long, a minimum of 4 inches (10.2 cm) high and between 2 inches (5.1 cm) and 3 inches (7.6 cm) deep.

4.5.14.2.1 Drain Horizontal recesses shall drain into the POOL.

4.5.14.2.2 Consecutive Recesses Horizontal recesses need not be continuous, but consecutive recesses shall be separated by no more than 12 inches (30.5 cm) of wall.

4.5.14.3 Decking Where PERIMETER GUTTER SYSTEMS are not provided, a coping or cantilevered DECKING of reinforced concrete or material equivalent in strength and durability, with rounded, SLIP-RESISTANT edges shall be provided.

4.5.14.4 Coping Dimensions The horizontal overhang for coping or cantilevered DECKING shall not be greater than 2 inches (5.1 cm) from the vertical plane of the POOL wall, nor less than 1 inch (2.5 cm).

4.5.14.5 Coping Thickness The vertical thickness of the coping or cantilevered DECKING shall not exceed 2.5 inches (6.4 cm) for the horizontal overhang.

4.5.15 Infinity Edges

4.5.15.1[A] Perimeter Restrictions Not more than fifty percent (50%) of the POOL perimeter shall incorporate an INFINITY EDGE detail, unless an adjacent and PATRON accessible DECK space conforming to MAHC 4.8.1 is provided.

4.5.15.2 Length The length of an INFINITY EDGE shall be no more than 30 feet (9.1 m) long when in water depths greater than 5 feet (1.5 m).

4.5.15.2.1 Shallow Water No maximum distance is enforced for the length of INFINITY EDGES in shallow water 5 feet (1.5 m) and less.

4.5.15.3[A] Handholds Handholds conforming to the requirements of MAHC 4.5.14 shall be provided for INFINITY EDGES, which may be separate from, or incorporated as part of the INFINITY EDGE detail.

4.5.15.4 Construction Guidance Where INFINITY EDGES are provided, they shall be constructed of reinforced concrete or other impervious and structurally rigid material(s) and designed to withstand the loads imposed by POOL water, BATHERS, and adjacent soils or structures.

4.5.15.5 Overflow Basins Troughs, basins, or capture drains designed to receive the overflow from INFINITY EDGES shall be watertight and free from STRUCTURAL CRACKS.

4.5.15.5.1 Finish Troughs, basins, or capture drains designed to receive the overflow from INFINITY EDGES shall have a non-toxic, smooth, and SLIP-RESISTANT finish.

4.5.15.6[A] Maximum Height The maximum height of the wall outside of the INFINITY EDGE shall not exceed 30 inches (76.2 cm) to the adjacent grade and capture drain.

4.5.16[A] Underwater Benches

4.5.16.1[A] Slip Resistant Where provided, UNDERWATER BENCHES shall be constructed with SLIP- RESISTANT materials.

4.5.16.2 Outlined Edges The leading horizontal and vertical edges of UNDERWATER BENCHES shall be outlined with a continuous slip-resistant, color-contrasting tile or other permanent marking of not less than ¾ inch (1.9 cm) and not greater than 2 inches (5.1 cm).

4.5.16.3[A] Maximum Water Depth UNDERWATER BENCHES may be installed in areas of varying depths, but the maximum POOL water depth in that area shall not exceed 5 feet (1.5 m).

4.5.16.4 Maximum Seat Depth The maximum submerged depth of any seat or sitting bench shall be 20 inches (50.8 cm) measured from the water line.

4.5.17 Underwater Ledges

4.5.17.1[A] Slip Resistant Where UNDERWATER TOE LEDGES are provided to enable swimmers to rest or to provide structural support for an upper wall, they shall be constructed with SLIP-RESISTANT materials.

4.5.17.2 Protrude UNDERWATER TOE LEDGES for resting that are recessed or protrude beyond the vertical plane of the POOL wall shall meet the criteria for SLIP RESISTANT and tread depth outlined in this section.

4.5.17.3[A] Five Feet or Greater UNDERWATER TOE LEDGES for resting shall only be provided within areas of a POOL with water depths of 5 feet (1.5 m) or greater.

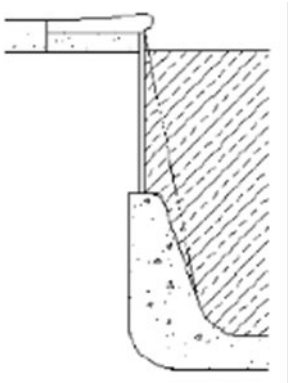
4.5.17.3.1 Underwater Toe Ledge UNDERWATER TOE LEDGES shall start no earlier than 4 lineal feet (1.2 m) to the deep side of the 5 foot (1.5 m) slope break.

4.5.17.3.2 Below Water Level UNDERWATER TOE LEDGES shall be at least 4 feet (1.2 m) below static water level.

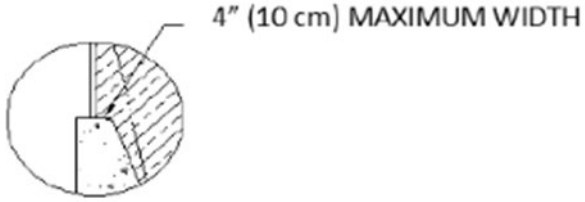
4.5.17.4[A] Structural Support UNDERWATER LEDGES for structural support of upper walls shall be allowed.

Figure 4.5.17.4: Structural Support Ledges

(A) Structural support ledge all within 1 in 5 slope.



(B) Underwater ledge for support of upper wall.



4.5.17.4.1 Ledge Slope All structural support ledges and slopes of the wall below shall fall within a plane sloped at a maximum of 1 horizontally in 5 vertically or 11 degrees from the water line down to a water depth of 5 feet (1.5 m). Refer to MAHC Figure 4.5.17.4.

4.5.17.4.2 Ledge Depth A structural support ledge shall be installed at a water depth of 3 feet (0.9 m) or deeper.

4.5.17.5 Outlined The edges of UNDERWATER TOE LEDGES and underwater structural support ledges shall be outlined with a continuous SLIP-RESISTANT, color-contrasting tile or other permanent marking of not less than 1 inch (2.5 cm) and not greater than 2 inches (5.1 cm).

4.5.17.5.1 Visible If they project past the plane of the POOL wall, the edges of UNDERWATER TOE LEDGES and underwater structural support ledges shall be clearly visible from the DECK.

4.5.17.6 Tread Depths UNDERWATER TOE LEDGES and underwater structural support ledges shall have a maximum uniform horizontal tread depth of 4 inches (10.2 cm). See MAHC Figure 4.5.17.4.

4.5.18[A] Underwater Shelves

4.5.18.1 Immediately Adjacent UNDERWATER SHELVES may be constructed immediately adjacent to water 3 feet 6 inches (1.1 m) or shallower.

4.5.18.2 Nosing UNDERWATER SHELVES shall have a SLIP-RESISTANT, color-contrasting nosing at the leading horizontal and vertical edges on both the top of horizontal edges and leading vertical edges and should be clearly visible from the DECK or from underwater.

4.5.18.3 Maximum Depth UNDERWATER SHELVES shall have a maximum depth of 24 inches (61.0 cm).

4.5.18.4 Depth Markings Depth markings required at the same spacing as required by MAHC 4.5.19 and are in addition to the depth marking locations on the deck as required by MAHC 4.5.19.

4.5.19 Depth Markers and Markings

4.5.19.1 Location

4.5.19.1.1 Markings POOL water depths shall be clearly and permanently marked at the following locations:

1) Minimum depth,
2) Maximum depth,
3) On both sides and at each end of the POOL, and
4) At the break in the floor slope between the shallow and deep portions of the POOL.

4.5.19.1.2[A] Depth Measurements Depth markers shall be located on the vertical POOL wall and positioned to be read from within the POOL.

4.5.19.1.3[A] Below Handhold Where depth markings cannot be placed on the vertical wall above the water level, other means shall be used so that the markings will be plainly visible to persons in the POOL.

4.5.19.1.4 Coping or Deck Depth markers shall also be located on the POOL coping or DECK within 18 inches (45.7 cm) of the POOL structural wall or perimeter gutter.

4.5.19.1.5 Read on Deck Depth markers shall be positioned to be read while standing on the DECK facing the POOL.

4.5.19.1.6 Twenty-Five Foot Intervals Depth markers shall be installed at not more than 25 (7.6 m)-foot intervals around the POOL perimeter edge and according to the requirements of this section.

4.5.19.1.6.1 Five Feet or Less For water less than 5 feet (1.5 m) in depth, the depth shall be marked at 1 foot (30.5 cm) depth intervals.

4.5.19.2 Construction / Size

4.5.19.2.1 Durable Depth markers shall be constructed of a durable material resistant to local weather conditions.

4.5.19.2.2 Slip Resistant Depth markers shall be SLIP RESISTANT when they are located on horizontal surfaces.

4.5.19.2.3[A] Color and Height Depth markers shall have letters and numbers with a minimum height of 4 inches (10.2 cm) of a color contrasting with background.

4.5.19.2.4[A] Feet and Inches Depth markers shall be marked in units of feet and inches.

4.5.19.2.4.1 Abbreviations Abbreviations of "FT" and "IN" may be used in lieu of "FEET" and "INCHES."

4.5.19.2.4.1.1 Abbreviations Symbols for feet (') and inches (") shall not be permitted on water depth signs.

4.5.19.2.4.2 Metric Metric units may be provided in addition to—but not in lieu of—units of feet and inches.

4.5.19.3 Tolerance Depth markers shall be located to indicate water depth to the nearest 3 inches (7.6 cm), as measured from the POOL floor 3 feet (0.9 m) out from the POOL wall to the gutter lip, mid-point of surface SKIMMER(S), or surge weir(s).

4.5.19.4 No Diving Markers

4.5.19.4.1[A] Depths For POOL water depths 5 feet (1.5 m) or shallower, all DECK depth markers required by MAHC 4.5.19 shall be provided with "NO DIVING" warning signs along with the universal international symbol for "NO DIVING."

4.5.19.4.1.1 Spacing "NO DIVING" warning signs and symbols shall be spaced at no more than 25 foot (7.6 m) intervals around the POOL perimeter edge.

4.5.19.4.2 Durable "NO DIVING" MARKERS shall be constructed of a durable material resistant to local weather conditions.

4.5.19.4.3 Slip Resistant "NO DIVING" MARKERS shall be SLIP RESISTANT when they are located on horizontal surfaces.

4.5.19.4.4 At Least Four Inches All lettering and symbols shall be at least 4 inches (10.2 cm) in height.

4.5.19.5[A] Depth Marking At Break in Floor Slope

4.5.19.5.1 Over Five Feet For POOLS deeper than 5 feet (1.5 m), a line of contrasting color, not less than 2 inches (5.1 cm) and not more than 6 inches (15.2 cm) in width, shall be clearly and permanently installed on the POOL floor at the shallow side of the break in the floor slope, and extend up the POOL walls to the waterline.

4.5.19.5.2 Durable Depth marking at break in floor slope shall be constructed of a durable material resistant to local weather conditions and be SLIP RESISTANT.

4.5.19.5.3 Rope and Float Line One foot (30.5 cm) to the shallower side of the break in floor slope and contrasting band, a ROPE AND FLOAT LINE shall extend across the POOL surface with the exception of WAVE POOLS, SURF POOLS, and WATERSLIDE LANDING POOLS.

4.5.19.6[A] Dual Marking System Symmetrical AQUATIC VENUE designs with the deep point at the center may be allowed by providing a dual depth marking system which indicates the depth at the wall as measured in MAHC 4.5.19.3 and at the deep point.

4.5.19.7 Non-Traditional Aquatic Venues Controlled-access AQUATIC VENUES (such as ACTIVITY POOLS, LAZY RIVERS, and other AQUATIC VENUES with limited access) shall only require depth markers on a sign at points of entry.

4.5.19.7.1 Clearly Visible Depth marker signs shall be clearly visible to PATRONS entering the VENUE.

4.5.19.7.2 Lettering and Symbols All lettering and symbols shall be as required for other types of depth markers.

4.5.19.8[A] Wading Pool Depth Markers AQUATIC VENUES where the maximum water depth is 6 inches (15.2 cm) of water or less (such as WADING POOLS and ACTIVITY POOL areas) shall not be required to have depth markings or "NO DIVING" signage.

4.5.19.9 Movable Floor Depth Markers For AQUATIC VENUES with movable floors, a sign indicating movable floor and/or varied water depth shall be provided and clearly visible from the DECK.

4.5.19.9.1 Vertical Measurement The posted water depth shall be the water level to the floor of the AQUATIC VENUE according to a vertical measurement taken 3 feet (0.9 m) from the AQUATIC VENUE wall.

4.5.19.9.2 Signage A sign shall be posted to inform the public that the AQUATIC VENUE has a varied depth and refer to the sign showing the current depth.

4.5.19.10 Spas A minimum of two depth markers shall be provided regardless of the shape or size of the SPA as per MAHC 4.12.1.6.

4.5.20 Aquatic Venue Shell Maintenance [N/A]

4.5.21[A] Special Use Aquatic Venues

4.5.21.1 Adequately Support The DESIGN PROFESSIONAL shall provide information to adequately support why the SPECIAL USE AQUATIC VENUE does not meet the definition and use characteristics of other categories of AQUATIC VENUES or POOLS listed in the CODE.

4.5.21.2 Justification The DESIGN PROFESSIONAL shall provide justification to support variance requests in accordance with MAHC 5.2.3 for design parameters that do not meet the design STANDARDS and construction requirements listed in MAHC 4.0.

4.6 Indoor / Outdoor Environment

4.6.1 Lighting

4.6.1.1 General Requirements

4.6.1.1.1 Outdoor Aquatic Venues Lighting as described in this subsection shall be provided for all outdoor AQUATIC VENUES open for use from 30 minutes before sunset to 30 minutes after sunrise, or during periods of natural illumination below the levels required in MAHC 4.6.1.3.1.

4.6.1.1.2 Accessible No lighting controls shall be accessible to PATRONS or BATHERS.

4.6.1.2[A] Windows / Natural Light Where natural lighting methods are used to meet the light level requirements of MAHC 4.6.1.3 during portions of the day when adequate natural lighting is available, one of the following methods shall be used to ensure that lights are turned on when natural lighting no longer meets these requirements:

1) Automatic lighting controls based on light levels or time of day or
2) Written operations procedures where manual controls are used.

4.6.1.3[A] Light Levels POOL water surface and DECK light levels shall meet the following minimum maintained light levels:

1) Indoor Water Surface: 30 horizontal footcandles (323 lux).
2) Outdoor Water Surface: 10 horizontal footcandles (108 lux).
3) DECK: 10 horizontal footcandles (108 lux).

4.6.1.3.1 Minimum Light Levels Maintained Where overhead lighting is adjustable to accommodate higher lighting levels for different activities, the minimum lighting level setting must ensure the minimum lighting levels are maintained as required at the POOL water surface and DECK whenever the lighting is on.

4.6.1.4[A] Overhead Lighting

4.6.1.4.1[A] Artificial Lighting Artificial lighting shall be provided at all which are to be used at night or which do not have adequate natural lighting.

4.6.1.4.2 Aquatic Venue Floor Lighting shall illuminate all parts of the floor of the AQUATIC VENUE to enable a QUALIFIED LIFEGUARD or other person to determine whether a BATHER is on the floor of the AQUATIC VENUE.

4.6.1.4.3 Aquatic Venue Illumination Lighting shall illuminate all parts of the AQUATIC VENUE including the water, the depth markers, signs, entrances, restrooms, safety equipment, and the required DECK area and walkways.

4.6.1.5[A] Underwater Lighting

4.6.1.5.1[A] Minimum Requirements Underwater lighting, where provided, shall be not less than eight initial rated lumens per square foot of POOL water surface area.

4.6.1.5.1.1 Location Such underwater lights, in conjunction with overhead or equivalent DECK lighting, shall be located to provide illumination so that all portions of the AQUATIC VENUE, including the AQUATIC VENUE bottom and drain(s), may be readily seen.

4.6.1.5.1.2 Higher Light Levels Higher underwater light levels shall be considered for deeper water to achieve this outcome.

4.6.1.5.2 Dimmable Lighting Dimmable lighting shall not be used for underwater lighting.

4.6.1.6[A] Night Swimming with No Underwater Lighting

4.6.1.6.1 Minimum Requirements Where outdoor POOLS are open for use from 30 minutes before sunset to 30 minutes after sunrise, or during periods of low illumination, underwater lighting may be excluded where:

1) Maintained POOL surface lighting levels are a minimum of 15 horizontal footcandles (161 lux), and
2) All portions of the POOL, including the bottom and drain(s), are readily visible as required in MAHC 5.7.6.1.

4.6.1.7[A] Emergency Lighting

4.6.1.7.1 Emergency Egress Lighting POOL areas requiring lighting shall be provided with emergency egress lighting in compliance with the applicable local, state, territorial, federal, and tribal building CODES.

4.6.1.7.2 Footcandles The path of egress shall be illuminated to at least a value of 0.5 footcandles (5.4 lux).

4.6.1.8[A] Glare Windows and any other features providing natural light into the POOL space and overhead or equivalent DECK lighting shall be designed or arranged to inhibit or reduce glare on the POOL water surface that would prevent seeing objects on the POOL bottom.

4.6.2[A] Indoor Aquatic Facility Ventilation

4.6.2.1[A] Purpose INDOOR AQUATIC FACILITY AIR HANDLING SYSTEMS shall be designed, constructed, and installed to support the health and SAFETY of the building's PATRONS.

4.6.2.2[A] Exemptions INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM design requirements do not apply to AQUATIC FACILITIES that do not meet the definition of a "Building" in the IBC 2012.

4.6.2.3 Indoor Aquatic Facility AIR HANDLING SYSTEM design requirements shall apply to new or SUBSTANTIALLY ALTERED INDOOR AQUATIC FACILITIES including the area of the building's AQUATIC VENUES and the surrounding BATHER and spectator/STADIUM SEATING areas.

4.6.2.4 Mechanical Code INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM design, construction, and installation shall comply with all applicable local, state, territorial, federal, and tribal laws.

4.6.2.5[A] ASHRAE 62.1 Compliance INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM design, construction, and installation shall comply with ASHRAE Standard 62.1 2019, Ventilation for Acceptable Indoor Air Quality, and all applicable local, state, territorial, federal, and tribal laws with additional requirements as stated in MAHC 4.6.2.6.

4.6.2.5.1 Weather Data The ASHRAE dehumidification weather data for the facility geographical location shall be used when calculating the effects of the ventilation air to the space it is being introduced. This shall be added to the evaporation load of all water surfaces when sizing the climate control equipment.

4.6.2.6 Temperature and Humidity Control

4.6.2.6.1 Mechanical Systems Ventilation shall be provided through mechanical systems and/or engineered openings for natural ventilation.

4.6.2.6.2[A] Design Factors and Performance Requirements The AIR HANDLING SYSTEM design engineer shall provide plan drawings and documentation with the following components showing the design meets the performance requirements per MAHC 4.6.2.7:

1) Building layout identifying the geographic location of the INDOOR AQUATIC FACILITY;
2) INDOOR AQUATIC FACILITY size including area in square feet and height;
3) The surface area for DRY DECK, PERIMETER DECK, POOL DECK, POOL water surface, and for STADIUM SEATING sections;
4) Theoretical peak occupancy per aquatic venue, spectator, and DECK spaces;
5) Placement of AIR HANDLING SYSTEM and other building outdoor air intakes exterior to the building;
6) Placement of AIR HANDLING SYSTEM and other building exhaust vents exterior to the building;
7) Placement of return air intakes within the INDOOR AQUATIC FACILITY;
8) Placement of supply air locations within the INDOOR AQUATIC FACILITY;
9) Identify system capabilities, if provided, to automatically or manually modulate the amount of outdoor air for the purposes of reducing the number of cfm of outdoor air when occupancy in STADIUM SEATING sections is lower than THEORETICAL PEAK OCCUPANCY;
10) Identify system design to maintain negative air pressure in the INDOOR AQUATIC FACILITY relative to the indoor areas external to it, or to the outside of the facility; and
11) Heating, cooling, and dehumidification load calculations including design envelope sensible cooling loads, envelope heating loads, ventilation sensible and latent loads, spectator sensible and latent loads (if applicable) and POOL evaporation loads.

4.6.2.6.3[A] Other Air Handling Systems AIR HANDLING SYSTEM design for CHEMICAL STORAGE SPACES, mechanical, toilet, SHOWER, and dressing rooms are not included in the scope of this section of the CODE, but shall be considered for their effects on the performance requirements of MAHC 4.6.2.7 such as maintaining negative pressure, temperature differences, and contribution to the air volume of the INDOOR AQUATIC FACILITY.

4.6.2.6.4 High Volume, Low Speed Fans AIR HANDLING SYSTEM design may not consider mechanical fans used to push air within the space as part of the outdoor air calculations for the INDOOR AQUATIC FACILITY as defined in MAHC 4.6.2.7.

4.6.2.6.4.1 Air Delivery Rate Mechanical fans used to push air within the space may be used in the calculation for AIR DELIVERY RATE per MAHC 4.6.2.7.5.

4.6.2.6.5 Occupied and Open All Seasons AIR HANDLING SYSTEM design may include natural ventilation calculated in accordance with the ASHRAE Handbooks to substitute the corresponding portion of mechanical ventilation only if all the calculated exterior openings will be continuously controlled open during all times the INDOOR AQUATIC FACILITY is occupied, regardless of season.

4.6.2.6.6 Air Distribution Design The design of the distribution of supply air and distribution of exhaust or return air shall consider obstacles such as support columns, architectural structures, and AQUATIC FEATURES.

4.6.2.7 Performance Requirements for Air Handling Systems

4.6.2.7.1[A] Designed to Maintain The AIR HANDLING SYSTEM shall be designed to maintain the space temperature, relative humidity and dewpoint as defined in Section 4.6.2.7. The design shall achieve the following objectives:

1) Maintaining homogeneous air quality, space temperature, relative humidity, and negative space pressure.
2) Delivering outside air to the breathing zone of swimmers, people on the DECK, and spectators.
3) Provide low velocity airflow low across water surfaces to prevent build-up of DBPs. If the air velocity is greater than 30 fpm (0.15 meters per second) across the water surface, the empirical Equation 1 Evaporation Formula as listed in the ASHRAE 2019 Applications Handbook (Indoor Pool Chapter) must be used.
4) Assist in removing DBPs from the space.
5) Provide a comfortable environment for occupants in all zones of the AQUATIC FACILITY (with an emphasis on BATHERS).

4.6.2.7.2[A] Minimum Outdoor Air Requirements The AIR HANDLING SYSTEM shall have a design capability to supply no less than the minimum outdoor air requirements using ASHRAE Standard 62.1 2016, Ventilation for Acceptable Indoor Air Quality.

4.6.2.7.2.1 May Be Higher The minimum outdoor air requirements may be higher than the amount calculated using ASHRAE Standard 62.1 2019 Table 6.2.2.1 (i.e., for high occupancy public POOLS and waterparks) as determined by the DESIGN PROFESSIONAL.

4.6.2.7.3[A] System Alarm The AIR HANDLING SYSTEM design shall provide system features to notify the operator if the outdoor air flow rate entering the INDOOR AQUATIC FACILITY is below 0.48 cfm/ft2 (1.8 m3/h) or the minimum amount as designated by the DESIGN PROFESSIONAL for each applicable mode of operation (e.g., occupied normal mode, occupied meet mode, unoccupied mode).

4.6.2.7.4 Outdoor Air Rate Design of the AIR HANDLING SYSTEM for STADIUM SEATING areas shall meet the requirements in ASHRAE 62.1-2019 for the Area Outdoor Air Rate (0.06 cfm/ft2) and the People Outdoor Air Rate (7.5 cfm/person) based on the THEORETICAL PEAK OCCUPANCY of the STADIUM SEATING area. Design of the AIR HANDLING SYSTEM for all other areas of the INDOOR AQUATIC FACILITY shall meet the requirements in ASHRAE 62.1-2019 for the Area Outdoor Air Rate for POOL and DECK areas (0.48 cfm/ft2).

4.6.2.7.4.1 Method to Determine If a method to determine real-time actual occupancy is available for STADIUM SEATING areas, then the system may modulate to reduce outdoor air cfm to meet the requirement for the actual occupancy in those areas for the associated time frame.

4.6.2.7.5 Air Delivery Rate The AIR HANDLING SYSTEM shall supply an AIR DELIVERY RATE as defined in ASHRAE Handbook – HVAC Applications 2019, Indoor Pool Design.

4.6.2.7.5.1 Latent and Sensible The AIR DELIVERY RATE shall be sufficient to meet the latent and sensible cooling loads and the heating loads of the space and to meet the requirements of the air distribution system defined in MAHC 4.6.2.7.6 through 4.6.2.7.9

4.6.2.7.6 Constant Air Flow INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM shall be designed to provide constant air flow through all parts of the INDOOR AQUATIC FACILITY to minimize any

stagnant areas, stratification of temperature and humidity, and provide homogeneous air quality, space temperature, relative humidity, and pressure throughout the space.

4.6.2.7.7[A] Relative Humidity The AIR HANDLING SYSTEM shall maintain the relative humidity in the space as defined in ASHRAE Handbook: HVAC Applications, 2019, Chapter 6.

4.6.2.7.7.1 Dew Point The AIR HANDLING SYSTEM shall be designed to maintain the dew point as defined in the Technical Details section in MAHC 4.6.2.6.2. The DESIGN PROFESSIONAL shall design the ENCLOSURE to limit condensation on surfaces of the INTERIOR SPACE as prescribed by the DESIGN PROFESSIONAL to ensure condensation is avoided on wall, ceiling, glass, and floor interior surface as well as the interior structure of these building components at all times so as to prevent damage to structural members and to prevent biological growth on walls.

4.6.2.7.7.2 Condensation & Mold Control The AIR HANDLING DISTRIBUTION SYSTEM shall be designed to inhibit condensation and mold by:

1) Maintaining homogeneous space conditions and
2) Flushing the outside walls and windows, which can have the lowest surface temperature and therefore the greatest chance for condensation.

4.6.2.7.8 Negative Air Pressure AIR HANDLING SYSTEM air flow shall be designed to maintain negative air pressure in the INDOOR AQUATIC FACILITY relative to the areas external to it (such as adjacent indoor spaces and outdoor ambient space).

4.6.2.7.9[A] Disinfection By-Product Removal Sufficient return/exhaust air intakes shall be placed near AQUATIC VENUE surfaces such that they remove the highest concentration of airborne DBPs.

4.6.2.7.9.1 Airflow Across Water Surface The AIR HANDLING SYSTEM shall be designed considering airflow across the water surface to promote removal of DBPS.

4.6.2.7.9.1.1 Sufficient Return Air Intakes Sufficient return air intakes shall be placed low in the space near AQUATIC VENUE surfaces such that they draw air across the water surfaces and pull in the highest concentration of airborne DBPs.

4.6.2.7.9.1.2 Source Capture Provided Where a source capture exhaust system is provided, the AIR HANDLING SYSTEM shall be designed to help move the air on the water surface towards the exhaust. This exhaust air should not be allowed to mix with any return airflow in the AIR HANDLING SYSTEM.

4.6.2.7.9.1.3 Air Velocities Air velocities shall not exceed 30 fpm (0.15 meters per second) so as not to increase the evaporation rate and dehumidification requirement unless adjustments are made to the evaporation rate as stated in section 4.6.2.7.1.

4.6.2.7.10 Re-Entrainment of Exhaust and Contaminants AIR HANDLING SYSTEM outdoor air intakes shall be located to avoid RE-ENTRAINMENT of exhaust air and contaminants from building systems including AIR HANDLING SYSTEM exhaust back into the facility.

4.6.2.7.10.1 System Exhaust AIR HANDLING SYSTEM exhaust from CHEMICAL STORAGE SPACES, mechanical, toilet, SHOWER, and dressing rooms shall not be directed into the AQUATIC FACILITY.

4.6.2.7.11 Access Control The AIR HANDLING SYSTEM shall be designed to provide a means to limit physical or electronic access to system control to the operator and anyone the operator deems to have access.

4.6.2.7.12[A] Purge The AIR HANDLING SYSTEM shall have the capability to periodically PURGE air for air quality maintenance or for emergency situations.

4.6.2.7.12.1 Purge Capacity The AIR HANDLING SYSTEM shall have a PURGE capacity equal or greater than two times the ASHRAE Standard 62.1 2019 level.

4.6.2.7.12.1.1 Manual Activation This PURGE shall be capable of being manually activated.

4.6.2.7.12.2 Outdoor Air If a system is designed with a purge mode, the outdoor air delivered during PURGE shall be heated or conditioned to a temperature and humidity established by the HVAC design engineer to address any condensation in the duct system, the AIR HANDLING SYSTEM, and the building surfaces.

4.6.2.7.13[A] Air Handling System Filters The AIR HANDLING SYSTEM design shall include filters for outdoor air and recirculated air with a MERV rating of 8.

4.6.2.8 Air Handling System Installation

4.6.2.8.1 Air Handling System Operation and Maintenance Manual The contractor installing the INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM shall provide the AQUATIC FACILITY owner with an operations and maintenance manual. Information to be included:

1) Mechanical drawing and specifications;
2) All manufacturers' operation and maintenance manuals;
3) All equipment startup and shutdown procedures;
4) PURGING and other SAFETY procedures;
5) Cleaning procedures;
6) General maintenance requirements with STANDARD replaceable parts listings and frequency of maintenance (e.g., filter cleaning frequencies, motor bearing maintenance);
7) Pressure differential specifications for filter replacement, filter replacement type, and frequency of cleaning or replacement;
8) Troubleshooting processes;
9) Frequency of required calibration of equipment;
10) Descriptions of general operating schemes; and
11) Contact information for all air handling manufacturers and their local representatives or authorized service companies.

4.6.2.9 Air Handling System Commissioning

4.6.2.9.1 System Commissioning A qualified, licensed professional shall commission the AIR HANDLING SYSTEM to verify that the installed system is operating properly in accordance with the system design.

4.6.2.9.2 Written Statement A written statement of commissioning shall be provided to the AQUATIC FACILITY owner including but not limited to:

1) The cfm outdoor air flowing into the INDOOR AQUATIC FACILITY during all modes of operation shall be verified at the time of commissioning,
2) The exhaust air cfm flowing through the system during all modes of operation shall be verified at the time of commissioning,
3) The supply air cfm flowing into the space and resulting air changes per hour during all modes of operation shall be verified at the time of commissioning, and
4) Air velocity measurements at 6 different locations around the POOL DECK area at 12 inches above the DECK surface.

4.6.3[A] Indoor/Outdoor Aquatic Facility Electrical Systems and Components

4.6.3.1[A] General Guidance

4.6.3.1.1 NEC Requirements Electrical wiring and systems shall comply with the requirements of the NEC.

4.6.3.1.1.1 Providing Relief Nothing in this CODE shall be construed as providing relief from any applicable requirements of the NEC or other applicable CODE.

4.6.3.1.2[A] Indoor Aquatic Facilities An INDOOR AQUATIC FACILITY shall be considered a wet and corrosive environment.

4.6.3.2[A] Electrical Equipment in Interior Chemical Storage Spaces

4.6.3.2.1[A] Wet and Corrosive CHEMICAL STORAGE SPACES shall be considered wet and corrosive environments.

4.6.3.2.2[A] Electrical Conduit Electrical conduit shall not enter or pass through an interior CHEMICAL STORAGE SPACE, except as required to service devices integral to the function of the room, such as pumps, vessels, controls, lighting and safety devices, or if allowed by the NEC.

4.6.3.2.2.1 Sealed and Inert Where required, the electrical conduit in an interior CHEMICAL STORAGE SPACE shall be sealed and made of materials that will not interact with any chemicals in the CHEMICAL STORAGE SPACE.

4.6.3.2.3[A] Electrical Devices Electrical devices or equipment shall not occupy an interior CHEMICAL STORAGE SPACE, except as required to service devices integral to the function of the room, such as pumps, vessels, controls, lighting, and safety devices.

4.6.3.2.4[A] Protected Against Breakage Lamps, including fluorescent tubes, installed in interior CHEMICAL STORAGE SPACES shall be protected against breakage with a lens or other cover, or be otherwise protected against the accidental release of hot materials.

4.6.4[A] Pool Water Heating

4.6.4.1[A] High Temperature When designing POOL heating equipment, measures shall be taken to prevent BATHER exposure to water temperatures in excess of 104°F (40°C).

4.6.4.2 Pressure Relief Device A listed pressure-relief device shall be installed to limit the pressure on the heating equipment to no more than the maximum value specified by the heating-equipment manufacturer and applicable CODES.

4.6.4.3 Code Compliance POOL-water heating equipment shall be selected and installed to preserve compliance with the applicable CODES, the terms of listing and labeling of equipment, and with the equipment manufacturer's installation instructions and applicable CODES.

4.6.4.4[A] Equipment Room Requirements Where POOL water heaters use COMBUSTION and are located inside a building, the space in which the heater is located shall be considered to be an EQUIPMENT ROOM, and the requirements of MAHC 4.9.1 shall apply.

4.6.4.4.1 Carbon Monoxide Detector A carbon monoxide detector with local alarming, CERTIFIED, LISTED, AND LABELED in accordance with UL 2075, shall be installed in all such EQUIPMENT ROOMS.

4.6.4.4.2 Adjacent Rooms All rooms that are immediately adjacent to spaces containing fuel burning equipment or vents carrying the products of combustion shall also be provided with locally alarming carbon monoxide detectors.

4.6.4.5 Exception Heaters CERTIFIED, LISTED, AND LABELED for the atmosphere shall be acceptable without isolation from chemical fumes and vapors.

4.6.5 First Aid Area

4.6.5.1A Station Design Design and construction of new AQUATIC FACILITIES shall include an area designated for first aid equipment and/or treatment.

4.6.6 Emergency Exit

4.6.6.1 Labeling Gates and/or doors which will allow egress without a key shall be clearly and conspicuously labeled in letters at least 4 inches (10.2 cm) high "EMERGENCY EXIT."

4.6.7 Drinking Fountains

4.6.7.1[A] Provided A drinking fountain shall be provided inside an AQUATIC FACILITY and shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 61-2020 and, if electric, UL 399.

4.6.7.1.1 Alternative Alternate locations or the use of bottled water shall be evaluated by the AHJ.

4.6.7.1.2 Common Use Area If the drinking fountain cannot be provided inside the AQUATIC FACILITY, it shall be provided in a common use building or area adjacent to the AQUATIC FACILITY entrance and on the normal path of BATHERS going to the AQUATIC FACILITY entrance.

4.6.7.2 Readily Accessible The drinking fountain shall be located where it is readily accessible and not a hazard to BATHERS per MAHC 4.10.2.

4.6.7.2.1 Not Located The drinking fountain shall not be located in a SHOWER area or toilet area.

4.6.7.3 Single Fountain A single drinking fountain shall be allowed for one or more AQUATIC VENUES within an AQUATIC FACILITY.

4.6.7.4 Angle Jet Type The drinking fountain shall be an angle jet type installed according to applicable plumbing CODES.

4.6.7.5 Potable Water Supply The drinking fountain shall be supplied with water from an approved potable water supply.

4.6.7.6 Wastewater The wastewater discharged from a drinking fountain shall be routed to an approved sanitary sewer system or other approved disposal area according to applicable plumbing CODES.

4.6.8 Garbage Receptacles

4.6.8.1 Sufficient Number Receptacles shall be provided within an AQUATIC FACILITY to ensure that garbage and refuse can be disposed of properly to maintain safe and sanitary conditions.

4.6.8.2 Number and Location The number and location of receptacles shall be at the discretion of the AQUATIC FACILITY manager.

4.6.8.3 Closable Receptacles shall be designed to be closed with a lid or other cover so they remain closed until intentionally opened.

4.6.9 Food and Drink Concessions

4.6.9.1 Meet AHJ Requirements Concessions for food and drink in an AQUATIC FACILITY shall meet all AHJ requirements.

4.6.10 Spectator Areas

4.6.10.1 Within Aquatic Facility Enclosure An area designed for use by spectators may be located within an AQUATIC FACILITY ENCLOSURE.

4.6.10.2 Deck When a spectator area or an access to a spectator area is located within the AQUATIC FACILITY ENCLOSURE, the DECK adjacent to the area or access shall provide egress width for the spectators in addition to the width required by MAHC 4.8.1.5.

4.6.10.2.1 Additional Width The additional width shall be based on the egress requirements in the applicable building CODE based on the THEORETICAL PEAK OCCUPANCY of the AQUATIC FACILITY served with a minimum width of 4 feet (1.2 m) and have either of the following qualities outlined in MAHC 4.6.10.2.1.1 or MAHC 4.6.10.2.1.2.

4.6.10.2.1.1 Barrier A BARRIER as defined in MAHC 4.8.6.1 located on the DECK to separate the DECK used by spectators from the PERIMETER DECK used by BATHERS.

4.6.10.2.1.1.1 Openings The BARRIER may have one or more openings directly into the BATHER areas.

4.6.10.2.1.2 Demarcation Line A demarcation line on the DECK that shows the separation between the DECK used by spectators and the PERIMETER DECK used by BATHERS.

4.6.10.3[A] Balcony A spectator or other area located in a balcony within 10 feet (3.0 m) of or overhanging any portion of an AQUATIC VENUE shall be designed to prevent jumping or diving into the AQUATIC VENUE.

4.6.10.4[A] Bleachers Bleachers in a spectator area shall be designed according to the ICC's most recent version of the 300 Standard or another applicable CODE.

4.6.11 Indoor Aquatic Facility Acoustics

4.6.11.1[A] Acoustic Design Criteria Acoustic design requirements shall apply to a new INDOOR AQUATIC FACILITY or one that undergoes SUBSTANTIAL ALTERATION.

4.6.11.2[A] Sound Absorption INDOOR AQUATIC FACILITIES shall be designed, constructed, and installed with an AVERAGE SOUND ABSORPTION COEFFICIENT (ALPHA BAR) of 0.20 or greater.

4.6.11.2.1[A] Facilities Used Primarily by Specific Hearing Populations An ALPHA BAR of 0.25 or greater shall be used for INDOOR AQUATIC FACILITIES designed primarily for use by children, the elderly, or persons with hearing difficulties.

4.6.11.3[A] Noise INDOOR AQUATIC FACILITIES shall be designed, constructed, and installed so that the noise generated by the AIR HANDLING SYSTEM does not exceed a NOISE CRITERION level of 50 (NC-50) or 55 dBA at any time while the INDOOR AQUATIC FACILITY is open for use.

4.6.11.4[A] Sound Absorbing Materials When part of the interior finish, acoustical materials or finishes used for SOUND ABSORPTION shall meet the design requirements of MAHC 4.2.2.1.1 and 4.2.2.2.3.

4.6.11.5[A] Concave Room Surfaces The design of INDOOR AQUATIC FACILITIES with a domed roof, gable roof, or other shape that may cause sound focusing, irrespective of the ALPHA BAR, shall address sound focusing, REVERBERATION, and echoes that would interfere with speech intelligibility.

4.7 Recirculation and Water Treatment

4.7.1 Recirculation Systems and Equipment

4.7.1.1[A] General

4.7.1.1.1 Equipped and Operated All AQUATIC VENUES shall be equipped and operated with a recirculation and filtration system capable of meeting the provisions outlined in MAHC 4.7.

4.7.1.1.2 Component Installation The installation of the recirculation and the filtration system components shall be performed in accordance with the designer's and manufacturer's instructions.

4.7.1.1.3 Recirculation System A water RECIRCULATION SYSTEM consisting of one or more pumps, pipes, return INLETS, suction outlets, tanks, filters, and other necessary equipment shall be provided.

4.7.1.2[A] 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 Treatment If SECONDARY TREATMENT is required for an INCREASED RISK AQUATIC VENUE as per MAHC 4.7.3.3.1.2, then SECONDARY TREATMENT 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.

4.7.1.3 Inlets

4.7.1.3.1[A] General

4.7.1.3.1.1 Hydraulically Balanced The RECIRCULATION SYSTEM shall be designed with sufficient flexibility to achieve a hydraulic apportionment that will ensure the following:

1) Effective distribution of treated water and
2) Maintenance of a uniform disinfectant residual and pH throughout the AQUATIC VENUE.

4.7.1.3.1.1.1[A] Alternative Design Justification Alternative designs shall be allowed based on adequate engineering justification which may include utilizing a computation fluid dynamics (CFD) model of the POOL design that documents in-POOL circulation without any dead zones.

4.7.1.3.1.2 Inlets Effective distribution of treated water shall be accomplished by either a continuous perimeter overflow system with integral INLETS or by means of directionally adjustable INLETS adequate in design, number, and location.

4.7.1.3.1.3 Adequate Mixing POOLS shall use wall and/or floor INLETS to provide adequate mixing.

4.7.1.3.1.3.1 Greater Than Fifty Feet Wide For POOLS greater than 50 feet wide (15.2 m), floor INLETS shall be required.

4.7.1.3.1.4 Other Inlet Types All other types of INLET systems not covered in this section shall be subject to approval by the AHJ with proper engineering justification to support a variance request under MAHC 5.2.3.

4.7.1.3.1.5 Hydraulically Sized INLETS shall be hydraulically sized to provide the design flow rates for each POOL area of multi-zone POOLS based on the required design TURNOVER RATE for each zone.

4.7.1.3.2[A] Floor Inlets

4.7.1.3.2.1 Uniformly Spaced Floor INLETS shall be spaced to effectively distribute the treated water throughout the POOL.

4.7.1.3.2.2 Flush with Bottom Floor INLETS shall be flush with the bottom of the POOL.

4.7.1.3.2.2.1 Distance Distance between floor INLETS shall be no greater than 20 feet (6.1 m).

4.7.1.3.2.2.2 Row A row of floor INLETS shall be located within 15 feet (4.6 m) of each side wall.

4.7.1.3.2.3 Spaced Floor INLETS, used in combination with wall INLETS, shall be spaced no greater than 25 feet (7.6 m) from nearest side walls.

4.7.1.3.3 Wall Inlets

4.7.1.3.3.1[A] Effective Mixing Wall INLET velocity shall mix the water effectively.

4.7.1.3.3.2 Adjustable INLETS shall be directionally adjustable to provide effective distribution of water.

4.7.1.3.3.3[A] Inlet Spacing Wall INLETS shall be spaced no greater than 20 feet (6.1 m) apart.

4.7.1.3.3.3.1 Corner INLETS shall be placed within 5 feet (1.5 m) of each corner of the POOL.

4.7.1.3.3.3.2 Skimmers INLETS shall be placed at least 5 feet (1.5 m) from a SKIMMER.

4.7.1.3.3.3.3 Isolated INLETS shall be placed at each stairway or ramp leading into a pool and in each recessed or isolated area of the POOL.

4.7.1.3.3.4 Directional Flow Wall INLETS shall not require design to provide directional flow if part of a manufactured gutter system in which the filtered return water conduit is contained within the gutter structure.

4.7.1.3.3.5[A] Dye Testing The AHJ may require dye testing to evaluate the mixing characteristics of the RECIRCULATION SYSTEM.

4.7.1.3.3.5.1 Failed Test If dye test reveals inadequate mixing in the POOL after 20 minutes, the RECIRCULATION SYSTEM shall be adjusted or modified to assure adequate mixing.

4.7.1.4 Perimeter Overflow Systems/Gutters

4.7.1.4.1 General

4.7.1.4.1.1[A] Skimming All POOLS shall be designed to provide SKIMMING for the entire POOL surface area with engineering rationale provided by the DESIGN PROFESSIONAL.

4.7.1.4.1.1.1 Around Entire Pool For POOLS that require a perimeter overflow system, the perimeter overflow system shall extend around the entire POOL perimeter except where noted in this CODE.

4.7.1.4.1.1.2[A] Novel Perimeter Overflow Systems Novel perimeter overflow system designs that do not extend around the entire POOL perimeter shall be permitted with proper engineering justification.

4.7.1.4.1.2 Zero Depth Entry ZERO DEPTH ENTRY POOLS shall have a continuous overflow trench that terminates as close to the side walls as practical including any zero-depth portion of the POOL perimeter.

4.7.1.4.1.2.1 Ends Where a perimeter overflow system cannot be continuous, the ends of each section shall terminate as close as practical to each other.

4.7.1.4.2[A] Perimeter Overflow System Size and Shape

4.7.1.4.2.1 Continuous Water Removal The gutter system shall be designed to allow continuous removal of water from the POOL'S upper surface at a rate of at least 125 percent of the total design recirculation flow rate.

4.7.1.4.2.2 Inspection Gutters shall permit ready inspection, cleaning, and repair.

4.7.1.4.3[A] Gutter Outlets Drop boxes, converters, return piping, or FLUMES used to convey water from the gutter shall be designed to:

1) Prevent flooding and BACKPRESSURE of skimmed water into the POOL and
2) Handle at least 125 percent of the total design recirculation flow rate.

4.7.1.4.4 Surge Tank Capacity

4.7.1.4.4.1[A] Net Surge Capacity All perimeter overflow systems shall be designed with an effective net surge capacity of not less than one gallon for each square foot (40.7 L/m2) of POOL surface area.

4.7.1.4.4.1.1 Surge Components Surge shall be provided within a surge tank, or the gutter or filter above the normal operating level, or elsewhere in the system.

4.7.1.4.4.2 Tank Capacity The tank capacity specified shall be the net capacity.

4.7.1.4.4.3 Tank Levels The DESIGN PROFESSIONAL shall define the minimum, maximum, and normal POOL operating water levels in the surge tank.

4.7.1.4.4.3.1 Marked The surge tank's minimum, maximum, and normal POOL operating water levels shall be marked on the tank so as to be readily visible for inspection.

4.7.1.4.4.4 Overflow Pipes Surge tanks shall have overflow pipes to convey excess water to waste via an air gap or other approved BACKPRESSURE prevention device.

4.7.1.4.5[A] Tolerances Gutters shall be level within a tolerance of plus or minus 1/16 inch (1.6 mm) around the perimeter of the AQUATIC VENUE.

4.7.1.4.6[A] Makeup Water System

4.7.1.4.6.1 Automatic Makeup Automatic makeup water supply equipment shall be provided to maintain continuous skimming of POOLS with Perimeter Overflow Systems.

4.7.1.4.6.2 Air Gap Makeup water shall be supplied through an air gap or other approved BACKPRESSURE prevention device.

4.7.1.5 Skimmers and Alternative Gutter Technologies Using In-Pool Surge Capacity

4.7.1.5.1 General

4.7.1.5.1.1 Manufactured The use of manufactured direct suction SKIMMERS shall be in accordance with the manufacturer's recommendations.

4.7.1.5.1.2[A] Provided Where SKIMMERS are used, at least one surface SKIMMER shall be provided for each 500 square feet (46 m2) of surface area or fraction thereof.

4.7.1.5.1.2.1 Conditions Additional SKIMMERS may be required to achieve effective skimming under site-specific conditions such as outdoor POOLS affected by winds or heavy CONTAMINANT loading.

4.7.1.5.1.3[A] Hybrid Systems Hybrid systems that incorporate surge weirs in the overflow gutters to provide for in-POOL surge shall meet all of the requirements specified for overflow gutters—with the exception of the requirements under MAHC 4.7.1.4.4 when the net surge capacity required by MAHC 4.7.1.4.4.1 is alternatively met by the in-POOL surge capacity.

4.7.1.5.1.3.1[A] Surge Weirs The number of surge weirs shall be based on the individual surge weir capacity and the operational apportionment of the total design recirculation flow rate.

4.7.1.5.1.3.1.1 Locations The location of the required number of surge weirs shall be uniformly spaced in the gutter sections.

4.7.1.5.1.4[A] Design Capacity When used, the SKIMMER SYSTEM shall be designed to handle up to 100% of the total design recirculation flow rate.

4.7.1.5.1.5 Pool Width Limitations POOLS using SKIMMERS shall not exceed 30 feet (9.1 m) in width.

4.7.1.5.2 Skimmer Location

4.7.1.5.2.1 Effective SKIMMERS shall be so located as to provide effective skimming of the entire water surface.

4.7.1.5.2.2 Steps and Recessed Areas SKIMMERS shall be located so as not to be affected by restricted flow in areas such as near steps and within small recesses.

4.7.1.5.2.3 Wind Direction Wind direction shall be considered in number and placement of SKIMMERS.

4.7.1.5.3[A] Skimmer Flow Rate The flow rate for the SKIMMERS shall comply with manufacturer data plates or NSF/ANSI 50 including Annex K.

4.7.1.5.4 Control

4.7.1.5.4.1 Weir Each SKIMMER shall have a weir that adjusts automatically to variations in water level over a minimum range of 4 inches (10.2 cm).

4.7.1.5.4.2 Trimmer Valve Each SKIMMER shall be equipped with a trimmer valve capable of distributing the total flow between individual SKIMMERS.

4.7.1.5.5 Tolerances

4.7.1.5.5.1 Skimmer Base The base of each SKIMMER shall be level with all other SKIMMERS in the POOL within a tolerance of plus or minus ¼ inch (6.4 mm).

4.7.1.5.6[A] Equalizers Prohibited SKIMMER equalizers shall be prohibited on all new construction or SUBSTANTIAL ALTERATION.

4.7.1.6[A] Submerged Suction Outlet

4.7.1.6.1 General Submerged suction outlet fitting assemblies (SOFAs), shall be CERTIFIED, LISTED, AND LABELED to the requirements of ANSI/APSP/ICC-16 2017 and shall be installed in accordance with the SOFA specific installation instructions, including minimum sump depth, pipe size(s), adapters frames, structural supports, and fasteners.

4.7.1.6.2 Number and Location SOFAs labeled as blockable shall be installed with a minimum of two fittings. SOFAs labeled unblockable shall be installed with one or more fittings, except for those installed and used as ANSI/APSP/ICC-16 Maintenance Drains or Fire Suppression Source Outlets (ref. 1.2.2), which may be a single outlet.

4.7.1.6.2.1 Flow Ratings SOFA system flow ratings shall be calculated as follows:

1) Blockable SOFA systems: the sum of the installation specific SOFA flow ratings minus the flow rating of a SOFA with the highest installed flow rating;
2) Unblockable SOFA systems: the sump of the installation specific flow rating(s).

4.7.1.6.2.1.1 Location SOFAs or outlets may be located on the bottom or side wall. Maintenance drains and SOFAs used to drain the POOL shall be located on the bottom and at the deepest point to achieve the objective of MAHC 4.5.2.3.

4.7.1.6.2.1.2 Connected Multiple outlets shall be connected to a single main suction pipe by branch line pipe that is not valved so as to be capable of operating independently.

4.7.1.6.2.2 Spaced Outlets shall be spaced within the minimum and maximum separation distances specified by SOFA specific installation instructions and spaced as specified by the DESIGN PROFESSIONAL for aesthetic and engineering reasons.

4.7.1.6.3 Tank Connection Where gravity outlets are used, the main drain outlet shall be connected to a surge tank, collection tank, or balance tank/pipe.

4.7.1.6.4[A] Flow Distribution and Control

4.7.1.6.4.1 Design Capacity The submerged suction outlet system piping shall be designed at a minimum to handle the total design recirculation flow rate.

4.7.1.6.4.1.1 Two Main Drain Outlets Where there are two main drain outlets, the branch pipe from each main drain outlet shall be designed to carry 100% of the total design recirculation flow rate.

4.7.1.6.4.1.2 Three or More Drains Where three or more main drain outlets are connected by branch piping in accordance with MAHC 4.7.1.6.2.1.1 through MAHC 4.7.1.6.2.1.3, the design flow through each branch pipe from each main drain outlet may be as follows:

1) Q_{max} for each drain= Q (total design recirculation flow rate) / (number of drains less one) and
2) $Q_{max}=Q_{total} / (N-1)$.

4.7.1.6.4.2 Proportioning Valve The single main drain suction pipe to the pump shall be equipped with a proportioning valve(s) to adjust the flow distribution between the main drain piping and the surface overflow system piping.

4.7.1.6.5 Flow Velocities

4.7.1.6.5.1 Standards Flow velocities shall meet ANSI/APSP-16 20171 based on 100% design flow through each main drain cover.

4.7.1.7 Piping

4.7.1.7.1 Design

4.7.1.7.1.1 Materials Piping system components in contact with swimming POOL water shall be of non-toxic material, resistant to corrosion, able to withstand operating pressures, chemicals, and temperatures.

4.7.1.7.1.2 Standards Piping and piping system component materials shall be suitable for potable water contact.

4.7.1.7.1.2.1 Certified, Listed, and Labeled Piping and piping system component materials shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 14, NSF/ANSI 50, or NSF/ANSI 61, as applicable.

4.7.1.7.1.2.2 Certified Piping and piping system component materials shall be CERTIFIED, LISTED, AND LABELED to a specific STANDARD by an ANSI-accredited certification organization.

4.7.1.7.2 Velocity in Pipes

4.7.1.7.2.1[A] Discharge Piping RECIRCULATION SYSTEM piping shall be designed so that water velocities do not exceed 8 feet (2.4 m) per second on the discharge side of the recirculation pump unless alternative values have proper engineering justification.

4.7.1.7.2.2[A] Suction Piping Suction piping shall be sized so that the water velocity does not exceed 6 feet per second (1.8 m/s) unless alternative values have proper engineering justification.

4.7.1.7.2.3[A] Additional Considerations Gravity piping shall be sized with consideration of available system head or as demonstrated by detailed hydraulic calculations at the total design recirculation flow rate.

4.7.1.7.3[A] Drainage and Installation

4.7.1.7.3.1 Temperature Variations Provisions shall be made for expansion and contraction of pipes due to temperature variations.

4.7.1.7.3.2 Drainage Provisions shall be made for complete drainage of all AQUATIC VENUE piping.

4.7.1.7.3.3 Supported All piping shall be supported continuously or at sufficiently close intervals to prevent sagging and settlement.

4.7.1.7.3.4 Prior to Backfilling Piping, including process piping, that is installed in trenches shall be inspected prior to backfilling.

4.7.1.7.4 Piping and Component Identification

4.7.1.7.4.1[A] Clearly Marked All exposed piping shall be clearly marked to indicate function.

4.7.1.7.4.2 Flow Direction and Source All piping shall be clearly marked to indicate type or source of water and direction of flow with clear labeling and/or color coding.

4.7.1.7.4.3 Valves All valves shall be clearly marked to indicate function with clear labeling and/or color coding.

4.7.1.7.4.4 Schematic Displayed A complete, easily readable schematic of the entire AQUATIC VENUE RECIRCULATION SYSTEM shall be openly displayed in the mechanical room or available to maintenance and inspection personnel.

4.7.1.7.5 Testing

4.7.1.7.5.1 Static Water Pressure Test Suction and supply POOL piping shall be subjected to a static hydraulic water pressure test for the duration specified by the DESIGN PROFESSIONAL or AHJ.

4.7.1.7.5.2 Greater Suction and supply AQUATIC VENUE piping shall be able to maintain the greater of the two following amounts of pressure:

1) 25% greater than the maximum design operating pressure of the system or
2) 25 psi (172 KPa).

4.7.1.8 Strainers and Pumps

4.7.1.8.1 Strainers

4.7.1.8.1.1 Strainer / Screen All filter recirculation pumps, except those for vacuum filter installations, shall have a strainer/screen device on the suction side to protect the filtration and pumping equipment.

4.7.1.8.1.2 Materials Strainers shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50.

4.7.1.8.2 Pumping Equipment

4.7.1.8.2.1[A] Variable Frequency Drives VFDs may be installed to control all recirculation and feature pumps.

4.7.1.8.2.2[A] Total Dynamic Head The recirculation pump(s) shall have adequate capacity to meet the total design recirculation flow rate at the maximum TDH required by the entire RECIRCULATION SYSTEM under the most extreme operating conditions (e.g., clogged filters in need of backwashing).

4.7.1.8.2.3 Required Flow Rate The pump shall be designed to maintain total design recirculation flow rate under all conditions.

4.7.1.8.2.4 Vacuum Limit Switches Where vacuum filters are used, a vacuum limit switch shall be provided on the pump suction line.

4.7.1.8.2.5 Maximum The vacuum limit switch shall be set for a maximum vacuum of 18 inches (45.7 cm) of mercury.

4.7.1.8.2.6 Pump Priming All recirculation pumps shall be self-priming or flooded-suction.

4.7.1.8.2.7 Net Positive Suction Head Requirement All recirculation pumps shall meet the minimum NPSH requirement for the system.

4.7.1.8.3[A] Operating Gauges

4.7.1.8.3.1 Vacuum Gauge A compound vacuum-pressure gauge shall be installed on the pump suction line as close to the pump as possible.

4.7.1.8.3.2 Suction Lift A vacuum gauge shall be used for pumps with suction lift.

4.7.1.8.3.3 Installed A pressure gauge shall be installed on the pump discharge line adjacent to the pump.

4.7.1.8.3.4 Easily Read Gauges shall be installed so they can be easily read.

4.7.1.8.3.5 Valves All gauges shall be equipped with valves to allow for servicing under operating conditions.

4.7.1.9 Flow Measurement and Control

4.7.1.9.1[A] Flow Meters A flow meter accurate to within +/- 5% of the actual design flow shall be provided for each filtration system.

4.7.1.9.1.1 Certified, Listed, and Labeled Flow meters shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 or 61 by an ANSI-accredited certification organization.

4.7.1.9.2 Valves All pumps shall be installed with a manual adjustable discharge valve to provide a backup means of flow control as well as for system isolation.

4.7.1.10[A] Flow Rates / Turnover Times

Table 4.7.1.10: Aquatic Venue Maximum Allowable Turnover Times

Type of Pools	Turnover Maximum
Activity Pools	2 hours or less
Diving Pools	8 hours or less
Interactive Water Play*	0.5 hours or less
Lazy River	2 hours or less
Plunge Pools	1 hour or less
Runout Slide	1 hour or less
Wading Pools*	1 hour or less
Wave Pools	2 hours or less
All Other Pools	6 hours or less
Surf Pools	Submit engineering justification from equipment manufacturer

*Shall have secondary treatment

Aquatic Venue Maximum Allowable Turnover Times for Spa, Therapy*, & Exercise Pools

Temperatures	Load	Turnover Maximum
≤ 72º–93ºF (22º–34ºC)	> 2,500 gals/person (9.46 m3)	4 hours or less
≤ 72º–93ºF (22º–34ºC)	> 450 gals/person (1.7 m3)	2 hours or less
≤ 72º–93ºF (22º–34ºC)	≤ 450 gals/person (1.7 m3)	1 hour or less
≥ 93°–104ºF (34º–40ºC)	All	0.5 hours or less

*Shall have secondary treatment

4.7.1.10.1 Maximum Allowable All AQUATIC VENUES shall comply with the above maximum allowable TURNOVER TIMES shown in MAHC Table 4.7.1.10.

4.7.1.10.2[A] Calculated The TURNOVER TIME shall be calculated based on the total volume of water divided by the total design recirculation flow rate through the filtration process.

4.7.1.10.2.1[A] Unfiltered Water Unfiltered water such as water that may be withdrawn from and returned to the AQUATIC VENUE for such AQUATIC FEATURES as SLIDES by a pump separate from the filtration system, shall not factor into TURNOVER TIME.

4.7.1.10.3[A] Turnover Times TURNOVER TIMES shall be calculated based solely on the flow rate through the filtration system.

4.7.1.10.3.1 Required The required TURNOVER TIME shall be the lesser of the following options:

1) The specified time in MAHC Table 4.7.1.10 or
2) The time required for individual components (e.g., three SKIMMERS with flow rates set by the manufacturer and an additional 20% for the main drains could exceed the minimum value in the table).

4.7.1.10.3.2 Total Volume The total volume of the AQUATIC VENUE system shall include the AQUATIC VENUE and any surge/balance tank.

4.7.1.10.3.3 Supply Water Where water is drawn from the AQUATIC VENUE to supply water to AQUATIC FEATURES (e.g., SLIDES, tube rides), the water may be reused prior to filtration provided the disinfectant concentration and pH of the supply water are maintained at required levels.

4.7.1.10.4[A] Reuse Ratio The ratio of INTERACTIVE WATER PLAY AQUATIC VENUE FEATURE water to filtered water shall be no greater than 3:1.

4.7.1.10.5[A] Flow Turndown System For AQUATIC FACILITIES that intend to reduce the recirculation flow rate below the minimum required design values when the POOL is unoccupied, the flow turndown system shall be designed as follows in MAHC 4.7.1.10.5.1 through MAHC 4.7.1.10.5.2.

4.7.1.10.5.1 Flowrate The system flowrate shall not be reduced more than 25% lower than the minimum design requirements and only reduced when the AQUATIC VENUE is unoccupied.

4.7.1.10.5.1.1 Clarity The system flowrate shall only be reduced if the minimum water clarity required under MAHC 5.7.6 is met and the turbidity level in the POOL is less than 0.5 NTU.

4.7.1.10.5.1.2 Disinfectant Concentration The turndown system shall be required to maintain required disinfectant concentration and pH at all times.

4.7.1.10.5.2 Increase When the turndown system is also used to intelligently increase the recirculation flow rate above the minimum requirement (e.g., in times of peak use to maintain water quality goals more effectively), the following requirements shall be met at all times:

1) Velocity requirements inside of pipes (per MAHC 4.7.1.7.2) and
2) Maximum filtration system flows.

4.7.2[A] Filtration

4.7.2.1 All Filters

4.7.2.1.1 Required Filtration shall be required for all AQUATIC VENUES that recirculate water.

4.7.2.1.2[A] Certified, Listed, and Labeled Filters All filters shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization or approved by the AHJ with proper engineering justification.

4.7.2.1.3 Appropriate Filter Media Filters shall use the appropriate filter media as recommended by the filter manufacturer for maximum clarity and cycle length for AQUATIC VENUE use.

4.7.2.1.4 Certified, Listed, and Labeled Filter Media All filter media, including alternative filter media, shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization and within the size specifications provided by the filter manufacturer and NSF/ANSI 50 or approved by the AHJ with proper engineering justification.

4.7.2.2 Granular Media Filters

4.7.2.2.1[A] General

4.7.2.2.1.1 Valves and Piping The granular media filter system shall have valves and piping to allow isolation, venting, complete drainage (for maintenance or inspections), and backwashing of individual filters.

4.7.2.2.1.2 Filtration Accessories Filtration accessories shall include the following items:

1) Influent pressure gauge,
2) Effluent pressure gauge,
3) Backwash sight glass or other means to view backwash water clarity, and
4) Manual air relief system.

4.7.2.2.2[A] Filter Location and Spacing

4.7.2.2.2.1 Installed Filters shall be installed with adequate clearance and facilities for ready and safe inspection, maintenance, disassembly, and repair.

4.7.2.2.2.2 Media Removal A means and access for easy removal of filter media shall be provided.

4.7.2.2.3 Filtration and Backwashing Rates

4.7.2.2.3.1[A] Operate High-rate granular media filters shall be designed to operate at no more than 15 GPM per square foot (37 m/h) when a minimum bed depth of 24 inches (61 cm) of media depth as measured from the top of the filter media bed without flow to the top of the laterals, nozzles, or similar system of retaining media inside the filter.

4.7.2.2.3.1.1 Less than Twenty-Four Inch Bed Depth When a bed depth is less than 24 inches (61 cm) of media depth as measured from the top of the filter media bed without flow to the top of the laterals, nozzles, or similar system of retaining media inside the filter, filters shall be designed to operate at no more than 12 GPM per square foot (29 m/h).

4.7.2.2.3.2[A] Backwash System Design The granular media filter system shall be designed to backwash each filter at a rate of at least 15 GPM per square foot (37 m/h) of filter bed surface area, unless explicitly prohibited by the filter manufacturer and approved at an alternate rate as specified in their NSF/ANSI 50 listing.

4.7.2.2.4[A] Minimum Filter Media Depth Requirements The minimum depth of filter media cannot be less than the depth specified by the manufacturer.

4.7.2.2.5 Differential Pressure Measurement Gauges Influent and effluent pressure gauges shall have the capability to measure up to a 20 pounds per square inch (138 KPa) increase in the differential pressure across the filter bed in increments of 1 pound per square inch (6.9 KPa) or less.

4.7.2.2.6[A] Coagulant Injection Equipment Installation If coagulant feed systems are used, they shall be installed with the injection point located before the filters as far ahead as possible, with electrical interlocks in accordance with MAHC 4.7.3.2.1.3.

4.7.2.3 Precoat Filters

4.7.2.3.1[A] Filtration Rates

4.7.2.3.1.1 Vacuum Precoat The design filtration rate for vacuum precoat filters shall not be greater than either:

1) 2 GPM per square foot (4.9 m/h) or
2) 2.5 GPM per square foot (6.1 m/h) when used with a continuous precoat media feed (commonly referred to as “body-feed”).

4.7.2.3.1.2 Pressure Precoat The design filtration rate for pressure precoat filters shall not be greater than two GPM per square foot (4.9 m/h) of effective filter surface area.

4.7.2.3.1.3 Calculate The filtration surface area shall be based on the outside surface area of the media with the manufacturer's recommended thickness of precoat media and consistent with their NSF/ANSI 50 listing and labeling.

4.7.2.3.2[A] Precoat Media Introduction System Process The precoat pipe system shall be capable of closed-loop precoating (i.e., recirculation of water with suspended precoat media through the filter without flow returning to the pool during the precoating process) to minimize the potential for filter media or debris to be returned to the POOL.

4.7.2.3.3[A] Uninterrupted Flow Valves and piping shall be configured so that flow through the precoat filter shall not be interrupted when switching from precoat mode to filtration mode.

4.7.2.3.3.1 Manufacturer Specification If equipment is provided for the continuous feeding of filter media to the filter influent, the equipment shall be used in accordance with the manufacturer’s specifications.

4.7.2.3.3.2 Filter Media Discharge All discharged filter media shall be handled in accordance with all applicable local, state, territorial, federal, and tribal laws.

4.7.2.4[A] Cartridge Filters

4.7.2.4.1[A] Filtration Rates The design filtration rate for surface-type cartridge filter shall not exceed 0.30 GPM per square foot (0.20 L/s/m2).

4.7.2.4.2[A] Supplied and Sized Filter cartridges shall be supplied and sized in accordance with the filter manufacturer's recommendation for AQUATIC VENUE use.

4.7.2.4.3[A] Spare Cartridge One complete set of spare cartridges shall be maintained onsite in a clean and dry condition.

4.7.3[A] Disinfection and pH Control

4.7.3.1 Chemical Addition Methods

4.7.3.1.1 Disinfection and pH DISINFECTION and pH control chemicals shall be automatically introduced through the RECIRCULATION SYSTEM.

4.7.3.1.1.1 Controller Used A chemical controller, as specified in MAHC 4.7.3.2.8 shall be provided and used for MONITORING and control of disinfectant and pH feed equipment.

4.7.3.1.1.2 Feeder DISINFECTION and pH control chemicals shall be added using a feeder that meets the requirements outlined in MAHC 4.7.3.2.

4.7.3.2 Feed Equipment

4.7.3.2.1[A] General

4.7.3.2.1.1 Required Chemical feeders shall be required in new or existing AQUATIC FACILITIES upon adoption of this CODE.

4.7.3.2.1.2 Feeders & Devices The AQUATIC FACILITY shall be equipped with chemical feed equipment such as flow-through chemical feeders, electrolytic chemical generators, mechanical chemical feeders, chemical feed pumps, and AUTOMATED CONTROLLERS that are CERTIFIED, LISTED, AND LABELED to NSF-ANSI 50 by an ANSI-accredited certification organization.

4.7.3.2.1.2.1 Specified by Manufacturer Flow-through chemical feeders shall only be used with the chemical (formulation, brand, size, and shape) specified by the chemical feeder manufacturer.

4.7.3.2.1.3 Interlock Controls and No or Low Flow Deactivation For all new or SUBSTANTIALLY RENOVATED AQUATIC VENUES and within 1 year of adoption of this CODE for existing facilities, all chemical control and feed systems shall be provided with an automatic means to disable all chemical feeders for each VENUE or portion of a VENUE in the event of a low flow or no flow condition. This shall be accomplished through an electrical interlock consisting of at least two of the following:

1) Recirculation pump power monitor,
2) Flow meter/flow switch/pressure switch in the return line, or
3) Flow meter/flow switch at the chemical controller.

4.7.3.2.1.3.1 Installed The electrical interlock system shall be installed per manufacturer's instructions and shall never be altered.

4.7.3.2.1.3.2 Visual Alarm For new installations and replacement equipment, if the feeder is disabled through the electrical interlock, a visual alarm or other indication shall be initiated that will alert staff onsite for BATHER evacuation.

4.7.3.2.1.4 Installation The chemical control and feed systems shall be installed according to the manufacturer's instructions.

4.7.3.2.1.4.1 Protective Cover A physical shield shall be installed between chemical feed pumps supplying acid or liquid hypochlorite solution and other POOL components to protect staff and equipment from chemical sprays from leaking connections.

4.7.3.2.2[A] Sizing of Disinfection Equipment

4.7.3.2.2.1 Sizing Feeders shall be capable of supplying disinfectant and pH control chemicals to the AQUATIC VENUE to maintain the DISINFECTION concentrations and pH at all times in accordance with the MAHC.

4.7.3.2.2.2 Chlorine Dosing All CHLORINE dosing and generating equipment including erosion feeders, or in line electrolytic and brine/batch generators, shall be designed with a capacity to meet the demand necessary to maintain the minimum required DPD-FC concentrations specified in MAHC 5.7.3.1.1.2 during all times of operation.

4.7.3.2.2.2.1 Chlorine Demand Factors Sizing of CHLORINE dosing and generating equipment shall be based on the following CHLORINE demand factors:

1) AQUATIC VENUE surface area;
2) AQUATIC VENUE volume;
3) AQUATIC VENUE type of use/space:
    a) FLAT WATER,
    b) AGITATED WATER, or
    c) HOT WATER;
4) AQUATIC VENUE type, for example: POOL, SPA, WADING POOL, WAVE POOL (wave time), WATERSLIDE, INTERACTIVE WATER PLAY VENUE, THERAPY POOL;
5) Indoor or outdoor including maximum hours of sunlight/UV exposure;
6) Anticipated maximum water temperature;
7) Anticipated maximum number of BATHERS per day;
8) Cyanuric acid/stabilizer used;
9) Anticipated atypical water loss; and
10) Anticipated exposure to vegetation and airborne debris.

4.7.3.2.2.3 Documentation The DESIGN PROFESSIONAL, who is registered or licensed to practice their respective design profession as defined by the local, state, territorial, federal, and tribal laws governing professional practice within the jurisdiction where the project is to be constructed, shall provide adequate documentation to demonstrate the selected feeders/equipment are of sufficient size and capacity per MAHC 4.7.3.2.2.1 and 4.7.3.2.2.2.

4.7.3.2.2.3.1 Information Included This documentation shall include:

1) An evaluation of the DISINFECTION feeder/equipment based on the DESIGN PROFESSIONAL'S related professional experience, the DISINFECTION feeder/equipment manufacturer's recommendations, or other industry accepted guidelines in sizing the feeders/equipment and
2) A discussion of the analysis and use of the CHLORINE demand factors listed in MAHC 4.7.3.2.2.2.1 in sizing the feeders/equipment.

4.7.3.2.2.4 Upon Operation If upon operation it is determined that feeders/equipment are not capable of meeting the demand necessary to maintain minimum required DISINFECTION concentrations at all times, additional capacity shall be provided.

4.7.3.2.3 Introduction of Chemicals

4.7.3.2.3.1 Separation The injection point of DISINFECTION chemicals shall be located before any pH control chemical injection point with sufficient physical separation of the injection points to reduce the

likelihood of mixing of these chemicals in the piping during periods of interruption of RECIRCULATION SYSTEM flow.

4.7.3.2.3.2 Backflow Means of injection shall not allow BACKFLOW into the chemical system from the POOL system.

4.7.3.2.3.3 Coagulants Coagulants shall be metered and injected through a pump system prior to the filters per the manufacturer's recommended rate.

4.7.3.2.4 Compressed Chlorine Gas

4.7.3.2.4.1 Prohibited for New Construction Use of compressed CHLORINE gas shall be prohibited for new construction and after SUBSTANTIAL ALTERATION to existing AQUATIC FACILITIES.

4.7.3.2.5[A] Types of Feeders

4.7.3.2.5.1 Liquid Solution Feeders Liquid solution feeders shall include positive displacement pumps such as peristaltic pumps, diaphragm pumps, and piston pumps.

4.7.3.2.5.1.1 Feed Rates Feed rates shall be locally adjusted on the pumps and also on/off controlled using an AUTOMATED CONTROLLER.

4.7.3.2.5.1.2 Routed All chemical tubing that runs through areas where staff work shall be routed in PVC piping to support the tubing and/or otherwise supported and protected to prevent leaks.

4.7.3.2.5.1.3 Size The double containment PVC pipe shall be of sufficient size to allow for easy replacement of tubing.

4.7.3.2.5.1.4 Turns Any necessary turns in the piping shall be designed so as to prevent kinking of the tubing.

4.7.3.2.5.2 Erosion Erosion feeders may be pressure, pressure differential, or spray erosion types.

4.7.3.2.5.2.1 Dry Chemical Feeders Dry chemicals shall be granules or tablets.

4.7.3.2.5.2.2 Located Feeders shall have isolation valves on each side of the feeder to be closed before opening the unit.

4.7.3.2.5.2.3 Source Water Erosion feeders shall use AQUATIC VENUE water post- filtration as the source water unless approved by the feeder manufacturer.

4.7.3.2.5.3 Gas Feed Systems Carbon dioxide and ozone are the only gas feed systems permitted in AQUATIC FACILITIES.

4.7.3.2.5.4 Ventilation Proper ventilation shall be required for all gas systems.

4.7.3.2.5.5 Alarms Where CO2 cylinders are located indoors, a monitor and alarm shall be provided to alert PATRONS/operator of high CO2 and/or low O2 concentrations.

4.7.3.2.5.6 UV Systems Where used, UV systems shall be installed in the RECIRCULATION SYSTEM after the filters.

4.7.3.2.5.6.1 Bypass A bypass pipe that is valved on both ends shall be installed to allow maintenance on the UV unit while the POOL is in operation.

4.7.3.2.5.6.2 Interlock UV system operation shall be interlocked with the recirculation pump so that power to the UV system is interrupted when there is no water flow to the UV unit per MAHC 4.7.3.2.1.3.

4.7.3.2.6 Salt Electrolytic Chlorine Generators, Brine Electrolytic Chlorine, or Bromine Generators

Halogen generator equipment shall be marked with an EPA establishment number.

4.7.3.2.6.1 Salt Electrolytic Chlorine Generators In-line generator(s) or brine (batch) generator(s) shall be permitted on AQUATIC VENUES.

4.7.3.2.6.2 In-line Method In-line generators shall use POOL-grade salt dosed into the AQUATIC VENUE to produce and introduce CHLORINE into the AQUATIC VENUE treatment loop through an electrolytic chamber.

4.7.3.2.6.3 Batch Method Brine (Batch) generators shall produce CHLORINE through an electrolytic cell.

4.7.3.2.6.3.1 Chlorine Production CHLORINE shall be produced from brines composed of POOL-grade salt.

4.7.3.2.6.4 TDS Readout Electrolytic generators shall have a TDS or salt (NaCl) readout and a low salt indicator.

4.7.3.2.6.5 Feed Rate The feed rate shall be adjustable from zero (0) to full range.

4.7.3.2.6.6 UL Standard The generator unit shall be CERTIFIED, LISTED, AND LABELED to UL 1081 (for electrical/fire/shock SAFETY) by an ANSI-accredited certification organization.

4.7.3.2.6.7 Interlock The generator(s) shall be interlocked per MAHC 4.7.3.2.1.3.

4.7.3.2.6.8 Installed The generator units shall be installed according to the manufacturer's instructions.

4.7.3.2.6.8.1 Saline Content The saline content of the POOL water shall be maintained in the required range specified by the manufacturer.

4.7.3.2.7[A] Feeders for pH Adjustment

4.7.3.2.7.1 Provided Feeders for pH adjustment shall be provided on all AQUATIC VENUES upon adoption of this CODE as in MAHC 4.7.3.2.1.2.

4.7.3.2.7.2 Approved Substances Approved substances for pH adjustment shall include but not be limited to muriatic (hydrochloric) acid, sodium bisulfate, carbon dioxide, sulfuric acid, sodium bicarbonate, and soda ash.

4.7.3.2.7.3 Adjustable pH adjustment feeders shall be adjustable from zero (0) to full range.

4.7.3.2.7.4 Marked Reservoirs shall be clearly marked and labeled with contents.

4.7.3.2.8[A] Automated Controllers

4.7.3.2.8.1 Required AUTOMATED CONTROLLERS shall be installed for MONITORING and turning on or off chemical feeders used for pH and disinfectants at all AQUATIC VENUES.

4.7.3.2.8.1.1 Existing Aquatic Facilities For existing AQUATIC FACILITIES, AUTOMATED CONTROLLERS shall be required within 1 year from adoption of this CODE.

4.7.3.2.8.2 NSF Standard All automated chemical controllers for pH and disinfectant MONITORING/control shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization.

4.7.3.2.8.3 Operation Manuals Operation manuals or other instructions that give clear directions for cleaning and calibrating AUTOMATED CONTROLLER probes and sensors shall be provided in close proximity to the AUTOMATED CONTROLLER.

4.7.3.2.8.4 Set Point A set point shall be used to target the disinfectant concentration and the pH.

4.7.3.3 Secondary Treatment

4.7.3.3.1 General Requirements

4.7.3.3.1.1[A] ANSI Listing and Labeling SECONDARY TREATMENT shall be CERTIFIED, LISTED, AND LABELED to ANSI/NSF 50 by an ANSI-accredited certification organization or approved by the AHJ with proper engineering justification.

4.7.3.3.1.1.1 Marked SECONDARY TREATMENT equipment using UV light shall be marked with an EPA establishment number.

4.7.3.3.1.2[A] Required Facilities The new construction or SUBSTANTIAL ALTERATION of the following INCREASED RISK AQUATIC VENUES shall be required to use a SECONDARY TREATMENT after adoption of this CODE:

3) 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
4) Therapy pools.

4.7.3.3.1.3 Other Aquatic Venues Optional SECONDARY TREATMENT 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 TREATMENT, 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 TREATMENT, 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[A] Log Inactivation and Oocyst Reduction

4.7.3.3.2.1[A] Log Inactivation SECONDARY TREATMENT shall be designed to achieve a minimum 3-log (99.9%) reduction in the number of infective *Cryptosporidium* OOCYSTS per pass through the SECONDARY TREATMENT for INTERACTIVE WATER PLAY AQUATIC VENUES and a minimum 2-log (99%) reduction per pass for all other AQUATIC VENUES. Each SECONDARY TREATMENT may be composed of multiple treatment processes or steps that result in the total required reduction in the number of infective *Cryptosporidium* OOCYSTS per pass through the SECONDARY TREATMENT.

4.7.3.3.2.2[A] Installation The SECONDARY TREATMENT 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, except on INTERACTIVE WATER PLAY AQUATIC VENUES. For INTERACTIVE WATER PLAY AQUATIC VENUES, the SECONDARY TREATMENT shall be located after the feature pump to treat 100% of the water prior to reaching the BATHERS.

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

4.7.3.3.2.4[A] Minimum Flow Rate Calculation The flow rate (Q) through the SECONDARY TREATMENT 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 (108) OOCYSTS to a concentration of one OOCYST/100 mL.

4.7.3.3.2.5[A] Equation The SECONDARY TREATMENT flow rate (Q) shall be:

1) $Q = V \times \{[14.8 - \ln(V)] / (r \times 60 \times T)\}$, where:
   a) Q = SECONDARY TREATMENT flow rate (GPM)

b) V = Total water volume of the AQUATIC VENUE or AQUATIC FEATURE, including surge tanks, piping, equipment, etc. (gals)

c) r = Efficiency of the system (r = 0.999 for 3-log reduction, r = 0.99 for 2-log reduction)

d) T = Dilution time (hrs.)

4.7.3.3.2.6 Time for Dilution Reduction 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.

4.7.3.3.2.7[A] Flow Rate Measurements Where a SECONDARY TREATMENT 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 TREATMENT shall be as defined in MAHC 4.7.3.3.2.5.

4.7.3.3.3[A] 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[A] Third Party Validation UV equipment shall be third party validated in accordance with the practices outlined in the EPA Ultraviolet Disinfectant Guidance Manual dated November, 2006, publication number EPA 815-R-06-007 or, alternatively for UV equipment designed for INTERACTIVE WATER PLAY AQUATIC VENUES, in accordance with the practices for wastewater treatment equipment outlined in the Water Environment Federation/International Ultraviolet Association (WEF/IUVA) WEF/IUVA publication "Ultraviolet Disinfection for Wastewater" dated April 2015, ISBN: 978-1-57278- 312-6.

4.7.3.3.3.1.1[A] Validation Standard The EPA Ultraviolet Disinfectant Guidance Manual and WEF/IUVA Ultraviolet Disinfection for Wastewater publication shall be considered recognized national STANDARDS 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 CERTIFIED, LISTED, AND LABELED to a specific STANDARD by an ANSI-accredited certification organization; and

3) As specified by the manufacturer.

4.7.3.3.3.3 Installation The UV equipment shall be installed after the filtration and before addition of primary disinfectant except on INTERACTIVE WATER PLAY AQUATIC VENUES. For INTERACTIVE WATER PLAY AQUATIC VENUES, the UV system shall be located after the feature pump to treat 100% of the water prior to reaching the BATHERS. When the features are off, the pumps shall continue to circulate a minimum amount of water back through the UV system returning to the collection tank, if required by the manufacturer for warm-up and cool-down purposes.

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[A] 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 onsite 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[A] 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 EPA Disinfection Guidance Manual, UV reactors certified by ÖNORM and DVGW for a Bacillus subtilis RED of 40mJ/cm2 shall be granted 3-log *Cryptosporidium* and 3-log *Giardia* inactivation credit as required in this CODE provided that the AQUATIC VENUE'S treated water UV TRANSMISSIVITY remains within the validated range of the UV system.

4.7.3.3.4 Ozone Disinfection

4.7.3.3.4.1[A] Log Inactivation SECONDARY TREATMENT using ozone shall provide the required inactivation of *Cryptosporidium* in the full flow of the SECONDARY TREATMENT after any side-stream has remixed into the full flow of the SECONDARY TREATMENT. The ozone contact time (in minutes) is determined by dividing the volume (in gallons) of water in the reaction (contact) tank by the flow rate (in gallons/minutes) through the reaction (contact) tank.

4.7.3.3.4.2[A] Onsite Measurement Ozone systems shall be designed to measure the concentration of ozone at a minimum of two sampling locations to determine the CT INACTIVATION VALUE achieved in the

treatment system prior to return of the water to the AQUATIC VENUE or AQUATIC FEATURE recirculation treatment loop. A CT INACTIVATION VALUE of 4.9 ppm (mg/L)*min is required for 99% (2 -log) *Cryptosporidium* reduction at a water temperature of 77°F /25° C (or 7.4 ppm [mg/L]*min is required for 99.9% [3 -log] *Cryptosporidium* reduction at a water temperature of 77°F/25° C).

4.7.3.3.4.3[A] 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 BACKPRESSURE 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[A] 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 by volume (ppmv or mL/m3) gaseous ozone.

4.7.3.3.4.9.1 Results Results of the test shall be maintained onsite 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 onsite 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 50.

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.

4.7.3.3.5 Filtration Removal of Cryptosporidium Oocysts Filtration systems to be used in SECONDARY TREATMENT for *Cryptosporidium* reduction in INCREASED RISK AQUATIC VENUES shall be certified by at least one of the following methods:

1) NSF Certified to confirm that they provide the specified log reduction of *Cryptosporidium* OOCYSTS or a conservative surrogate using realistic AQUATIC VENUE water quality values and operating conditions.
2) ANSI-accredited third-party testing and certification organization confirmation that they provide the specified log reduction of *Cryptosporidium* OOCYSTS or a conservative surrogate using realistic AQUATIC VENUE water quality values and operating conditions.
3) Peer-reviewed literature values with specified log reduction of *Cryptosporidium* OOCYSTS or a conservative surrogate using realistic AQUATIC VENUE water quality values and operating conditions.

4.7.3.4 Supplemental Treatment Systems

4.7.3.4.1 General Requirements

4.7.3.4.1.1[A] Optional AQUATIC VENUES that do not require SECONDARY TREATMENT may install SUPPLEMENTAL TREATMENT systems for the purpose of enhancing overall system performance and improving water quality.

4.7.3.4.1.2 Clearly Noted The AQUATIC FACILITY operating instructions shall clearly note that these SUPPLEMENTAL TREATMENT SYSTEMS do not meet the requirements of a SECONDARY TREATMENT, and as such, are only considered SUPPLEMENTAL TREATMENT SYSTEMS.

4.7.3.4.1.3 No Log Inactivation Required SUPPLEMENTAL TREATMENT SYSTEMS shall meet all of the requirements of this CODE, except:

1) They do not need to achieve the minimum log inactivation of *Cryptosporidium* parvum as required in MAHC 4.7.3.3;
2) They do not need to be able to reduce the total number of infective OOCYSTS to one OOCYST per 100 mL as required in MAHC 4.7.3.3; and
3) Except as noted in MAHC 4.7.3.4.2 and 4.7.3.4.3 below.

4.7.3.4.1.4 Clearly Labeled Each system shall be clearly labeled, "Supplemental Water Treatment System—Does Not meet the requirements for Secondary Disinfection."

4.7.3.4.2[A] Ultraviolet Light

4.7.3.4.2.1 UV as Supplemental Treatment Requirement When UV is used as a SUPPLEMENTAL TREATMENT system, all requirements of MAHC 4.7.3.3.3.2 through 4.7.3.3.3.4 shall be met.

4.7.3.4.2.2 Water Features Water features shall not require shut off if the supplemental UV system does not produce the required dosage.

4.7.3.4.2.3 Exempt The equipment is exempt from the validation requirements of MAHC 4.7.3.3.3.1.

4.7.3.4.3[A] Ozone

4.7.3.4.3.1 Ozone as Supplemental Treatment Requirement When ozone is used as a SUPPLEMENTAL TREATMENT system, all requirements of MAHC 4.7.3.3.4.3 thru 4.7.3.3.4.9 shall be met.

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

4.7.3.4.4[A] Copper / Silver Ion Systems

4.7.3.4.4.1 Only EPA–Registered Disinfectants Only those systems that are EPA REGISTERED for use as disinfectants in AQUATIC VENUES or SPAS in the United States shall be permitted.

4.7.3.4.4.2 Suitable Copper/silver systems, and all materials used therein, shall be suitable for their intended use.

4.7.3.4.4.3 Installed Copper/silver systems, and all materials used therein, shall be installed in accordance with all applicable requirements and manufacturer's instructions.

4.7.3.4.5[A] Ultraviolet Light / Hydrogen Peroxide Systems UV light / hydrogen peroxide combination systems shall be prohibited for use in aquatic facilities.

4.7.3.5[A] Water Quality Testing Devices and Kits

4.7.3.5.1 Compliance WQTDS and kits shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization.

4.7.3.5.2 ***Water Clarity Device*** Refer to MAHC 5.7.6 for guidance on water clarity devices.

4.7.3.6[A] Microbiological Testing Equipment

4.7.3.6.1 ***EPA Approved*** Microbiological testing equipment and methods shall be:

1) EPA Approved, EPA Accepted, EPA Equivalent;
2) Conforming to the latest edition of Standard Methods for the Examination of Water and Wastewater; or
3) CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization.

4.7.4[A] Water Replenishment System

4.7.4.1[A] Discharge and Measure A WATER REPLENISHMENT SYSTEM consisting of a means to intentionally discharge and measure or calculate the volume of both discharged AQUATIC VENUE water and filter backwash wastewater (or alternate means of achieving the same result) shall be provided.

4.7.4.1.1[A] ***Alternate System*** An alternate system capable of removing an equivalent amount of turbidity, total dissolved organic carbon (TOC), and total nitrogen (TN) containing compounds shall also be acceptable in lieu of discharging AQUATIC VENUE water.

4.7.4.1.1.1 ***Product Water*** When an alternate system is used, the return water from the alternate system shall maintain turbidity, total organic carbon, and total nitrogen concentrations that are less than or equal to the AQUATIC VENUE water supply.

4.7.4.1.2 ***Discharge*** The WATER REPLENISHMENT SYSTEM shall be designed to discharge (or treat and reuse via a separate treatment system capable of removing compounds specified in MAHC 4.7.4.1.1) AQUATIC VENUE water at a rate of at least 4 gallons (15 L) per BATHER per day per AQUATIC VENUE.

4.7.5 Spas

4.7.5.1[A] General

4.7.5.1.1 ***Requirements*** SPAS shall conform to the design, operation, and maintenance requirement of AQUATIC VENUES except as required below.

4.7.5.2 Flow Rates/Turnover Times

4.7.5.2.1 ***Maximum Allowable*** All SPAS shall be designed to have a maximum allowable TURNOVER TIME of 0.5 hour or less.

4.7.5.2.2 ***Turnover Times*** TURNOVER TIMES shall be calculated based solely on the flow rate through the filtration system.

4.7.5.3 Filtration System Inlets SPAS shall have a minimum of two adjustable filter system INLETS located below the surface of the UNDERWATER BENCH and spaced at least 3 feet (0.9 m) apart and designed to distribute flow evenly.

4.7.5.4 Hydrotherapy Jet System Inlets

4.7.5.4.1 ***Air Flow*** Air flow shall be permitted through the hydrotherapy jet system and/or when injected post-filtration.

4.7.5.4.2 ***Skimmer*** Submerged suction SKIMMERS shall be allowed provided that the manufacturer's recommendations for use are followed.

4.7.5.4.3 ***Independent*** The hydrotherapy jet system shall be independent of the recirculation, filtration, and heating systems.

4.8 Decks and Equipment

4.8.1 Decks

4.8.1.1 General Standards for All Decks

4.8.1.1.1[A] Lifeguard Placement and Safety Considerations DECKS shall be designed to allow for QUALIFIED LIFEGUARD placement per the zone of BATHER surveillance in MAHC 6.3.3.1.1 and safety areas and equipment in MAHC 4.8.5.

4.8.1.1.1.1[A] Deck Clearance DECKS shall have a minimum of 4 feet (1.2 m) of clearance from AQUATIC VENUE edge to fencing or other obstruction to allow for QUALIFIED LIFEGUARD transit, roaming, or change of positioning to maximize viewing of the zone of BATHER surveillance as well as execution of water extrication.

4.8.1.1.1.2[A] Access Points Access points shall be provided to QUALIFIED LIFEGUARDS to transit to QUALIFIED LIFEGUARDS positions.

4.8.1.1.1.3[A] Bather Zone Surveillance The designer and owner shall consider impact on BATHER zone surveillance when determining placement of structural, operational, and theming elements.

4.8.1.1.1.3.1 Elements for Deck Placement These elements shall include but are not limited to chairs, fencing, ADA access equipment, and AQUATIC FEATURES.

4.8.1.1.2 Joints or Gaps Conditions between adjacent DECK materials, components, and concrete pours shall not have horizontal open joints or gaps larger than 3/16 inches wide (4.8 mm).

4.8.1.1.2.1 Vertical Elevation Any change in vertical elevation between adjacent DECK materials, components, and concrete pours exceedi¼1/4 inches (6.4 mm) shall be considered an edge condition and shall be treated according to MAHC 4.8.1.1.2.2 or MAHC 4.8.1.1.3.

4.8.1.1.2.2 Fillers Open joints or gaps larger than 3/16 inches (4.8 mm) wide or with vertical elevations exceeding ¼ inches (6.4 mm) shall be rectified using appropriate fillers.

4.8.1.1.2.3 Sealants The use of fillers such as caulk or sealant in joints or gaps shall be permitted for expansion and contraction.

4.8.1.1.2.4 No Violation The use of fillers such as caulk or sealant in joints or gaps shall not be in violation of MAHC 4.8.1.1.3.

4.8.1.1.3 Rounded Edges All DECK edges shall be beveled, rounded, or otherwise relieved to eliminate sharp corners.

4.8.1.1.4 Minimize Cracks Joints in DECKING shall be provided to minimize the potential for CRACKS due to a change in elevation, for movement of the slab and for shrinkage control.

4.8.1.1.5[A] Concrete Decking Where concrete is used as a DECK material, it shall be installed in accordance with the latest edition of the American Concrete Institute (ACI) Standards and in accordance with applicable local, state, territorial, federal, and tribal building CODES.

4.8.1.1.6 Access Hatches Any access hatches located within the surface of the DECK shall be lockable, SLIP RESISTANT, and designed to maintain acceptable surface temperatures to allow barefoot traffic.

4.8.1.2[A] Standards for Perimeter Decks

4.8.1.2.1 Impervious Finish materials for the PERIMETER DECK shall be suitable for the POOL environment, non-toxic, and substantially impervious.

4.8.1.2.2 Watertight Expansion Continuous watertight EXPANSION JOINT material shall be provided between PERIMETER DECKS and POOL coping.

4.8.1.2.2.1 Expansion Joint Where applicable, the EXPANSION JOINT shall be designed and constructed so as to protect the coping and its mortar bed from damage as a result of movement of adjoining DECK.

4.8.1.2.3 Watertight Expansion All conditions between adjacent concrete PERIMETER DECK pours shall be constructed with watertight EXPANSION JOINTS.

4.8.1.2.3.1 Joint Measurements Joints shall be at least 3/16 inches (5 mm) in continuous width.

4.8.1.2.3.2 Vertical Differential The maximum allowable vertical differential across a joint shall be ¼ inches (6.5 mm).

4.8.1.3 Drains Refer to MAHC 4.11.4 for additional guidance on drains.

4.8.1.3.1[A] Slope DECKS shall be sloped away from the AQUATIC VENUE and in accordance with MAHC Table 4.8.1.3 below.

Table 4.8.1.3 Minimum Slopes for Drainage

Surface	Minimum Slope
Smooth finishes; such as tile, hand-finished concrete & lightly- broomed concrete	1/8 inch per foot (3.2 mm/30.5 cm)
Moderately textured finishes; such as exposed aggregate or medium-broomed concrete	1/4 inch per foot (6.4 mm/30.5 cm)
Heavily textured finishes; such as brick (where permitted)	3/8 inch per foot (9.5 mm/30.5 cm)

4.8.1.3.1.1 Accessible Routes Where DECK areas or portions thereof serve as ACCESSIBLE ROUTES, slopes in any direction shall not exceed ADA requirements.

4.8.1.3.1.2 All Water All water that touches areas defined as DECK, including water originating in the AQUATIC VENUE, shall drain effectively to either perimeter areas or to DECK drains.

4.8.1.3.1.3 Remove Wastewater Drainage shall remove AQUATIC VENUE water that splashes outside of the AQUATIC VENUE and beyond a POOL gutter system, DECK cleaning water, and rain water without leaving standing water.

4.8.1.3.2 Placement The placement of DECK drains, where provided, shall effectively carry water away from the AQUATIC VENUE and off the DECK without ponding.

4.8.1.3.3[A] Cross-Connection Control There shall be no direct connection between the DECK drains and the sanitary or storm sewer system.

4.8.1.3.3.1 Discharge to Sewer or Other Ground Water If the AHJ requires an outdoor POOL to have DECK drains that discharge to a storm sewer system, ground surface, or holding pond, the POOL shall be plumbed through an air-gap, BACKFLOW preventer, or other approved device as allowed by the AHJ.

4.8.1.3.3.2[A] No Drain DECK drains shall not drain to the POOL, POOL gutter, or RECIRCULATION SYSTEMS.

4.8.1.3.4 Drain Bodies Drain receptacles shall consist of non-corrosive or corrosion-resistant materials.

4.8.1.3.5 Drain Covers Drain covers shall be suitable for bare foot traffic with openings no greater than ½ inch (1.3 cm) and easily removable with a simple tool to facilitate regular cleaning.

4.8.1.4 Materials / Slip Resistant

4.8.1.4.1 General PERIMETER DECK and POOL DECK shall be constructed with a uniform and easily cleaned surface such as concrete, tile, manufactured or acrylic surfaces.

4.8.1.4.2[A] Slip Resistant All DECKS shall have SLIP-RESISTANT, textured finishes, which are not conducive to slipping under contact of bare feet in wet or dry conditions.

4.8.1.4.3[A] Carpet Carpet and artificial turf shall be prohibited materials for PERIMETER DECK and POOL DECK.

4.8.1.4.4[A] Wood Wood shall be a prohibited material for use as PERIMETER DECK.

4.8.1.4.5[A] Dry Deck DRY DECK shall be easily maintained and not create a public health hazard.

4.8.1.4.5.1 Not Required DRY DECK shall not be required to be hard-paved or impervious.

4.8.1.4.5.2 Wood Decking Wood DECKING may be permitted for DRY DECK.

4.8.1.4.6[A] Landscaping Loose plant material or bedding shall not be permitted within PERIMETER DECKS.

4.8.1.4.6.1 Stable Materials Stable materials are permitted.

4.8.1.5[A] Deck Size / Width

4.8.1.5.1 Perimeter Deck

4.8.1.5.1.1[A] Width PERIMETER DECKS shall be 4 feet (1.2 m) minimum in unobstructed width around the POOL perimeter as prescribed in this section.

4.8.1.5.1.1.1 Circulation Path Perimeter DECK may serve as part of the CIRCULATION PATH.

4.8.1.5.1.1.2 Flush with Pool Wall PERIMETER DECK areas shall be flush with POOL walls/copings except where special conditions exist, such as elevated beam or parapet, raised transfer walls, or as permitted by other sections of this CODE.

4.8.1.5.1.2[A] Perimeter Decking PERIMETER DECKS shall be provided around 100% of the AQUATIC VENUE perimeter except where special conditions exist as permitted by other sections of this CODE.

4.8.1.5.1.3[A] Unguarded Aquatic Venues For unguarded POOLS, PERIMETER DECKS shall be provided in compliance with at least one of two options:

1) Provide PERIMETER DECK around 100% of the of the POOL perimeter or
2) Provide PERIMETER DECK such that the entire perimeter and depth of the POOL is readily reachable by a pole and hook from the PERIMETER DECK.

4.8.1.5.1.4 Spectator Seating Refer to MAHC 4.6.10 for more information on spectator areas.

4.8.1.5.2 Fixed Equipment

4.8.1.5.2.1 Unobstructed Deck Unobstructed DECK area 4 feet (1.2 m) minimum in width shall be provided for access around:

1) Diving equipment,
2) Special feature stairways (such as a WATERSLIDE),
3) Lifeguard stands,
4) Diving boards,

5) Similar DECK equipment,

6) ADA access equipment, and

7) Structural columns.

4.8.1.5.2.2 Circulation Path This unobstructed area may overlap the CIRCULATION PATH.

4.8.1.5.2.3 Queuing Space Where reasonably anticipated, queuing space shall be provided at applicable equipment to minimize encroachment into the CIRCULATION PATH.

4.8.1.5.2.4 Free Space Free area around equipment may consist of PERIMETER DECK and/or POOL DECK, as applicable.

4.8.1.5.3 Circulation Path

4.8.1.5.3.1 Conformance A continuous and unobstructed CIRCULATION PATH shall be provided in conformance with ADA requirements for an ACCESSIBLE ROUTE.

4.8.1.5.3.2 Equipment and Furniture DECK furniture locations shall be designed not to intrude upon any CIRCULATION PATH.

4.8.1.5.3.3 Connect CIRCULATION PATHS shall connect all site amenities, entrances, and exits as required by ADA.

4.8.1.5.3.4 Deck Types CIRCULATION PATHS may consist of any combination of permitted DECK types.

4.8.1.6 Wing Walls or Peninsulas

4.8.1.6.1[A] No Perimeter Deck WING WALLS or PENINSULAS less than 18 inches (45.7 cm) in width shall not be considered a part of the PERIMETER DECK.

4.8.1.6.1.1 Use by Lifeguards A WING WALL or PENINSULA greater than 18 inches (45.7 cm) wide but less than 48 inches (1.2 m) wide may be used by QUALIFIED LIFEGUARD personnel but shall not be considered as part of the PERIMETER DECK. If a WING WALL or PENINSULA is 48 inches (1.2 m) or wider, it shall be considered as part of the PERIMETER DECK.

4.8.1.6.1.2 Slip Resistant Any WING WALL or PENINSULA shall be constructed of SLIP-RESISTANT materials.

4.8.1.6.2[A] Perimeter Overflow System If it is impractical to design a perimeter overflow system into a WING WALL or PENINSULA that is less than 48 inches (1.2 m) wide, then the overflow system may bypass the WING WALL or PENINSULA.

4.8.1.6.3[A] Pool Perimeter WING WALLS and PENINSULAS shall be considered part of the POOL.

4.8.1.6.3.1 Calculating WING WALLS and PENINSULAS shall not be accounted for in calculating the POOL perimeter.

4.8.1.6.4 Normal Operating Water Level WING WALLS and PENINSULAS shall be at or above the normal operating water level of the POOL.

4.8.1.6.5[A] Deck Drainage DECK drainage shall not be required for WING WALLS or PENINSULAS that are less than 48 inches (1.2 m) wide as they are considered part of the POOL.

4.8.1.6.5.1 Crowned The tops shall be crowned to prevent standing water and sloped to the POOL or overflow system.

4.8.1.6.6 Vertical Depth Markers Vertical depth markers shall be provided around WING WALLS and PENINSULAS in accordance with MAHC 4.5.19.

4.8.1.7[A] Islands

4.8.1.7.1 Minimum Width An ISLAND not more than 18 inches (45.7 cm) in width shall be designed to discourage a person from walking on the ISLAND by not providing stairs, ladders, or bridges to the ISLAND.

4.8.1.7.2 Slip Resistant The surface of ISLANDS shall be SLIP RESISTANT.

4.8.1.7.3 Lifeguards An ISLAND 18 inches (45.7 cm) to 48 inches (1.2 m) wide may be allowed for use only by QUALIFIED LIFEGUARDS.

4.8.1.7.4 Vertical Depth Markers Vertical depth markers shall be provided around ISLANDS in accordance with MAHC 4.5.19 and visible from all sides.

4.8.1.7.5 Horizontal Depth Markers Horizontal depth markings and warning signs shall also be required per MAHC 4.5.19 if the ISLAND is designed for BATHER use.

4.8.1.7.5.1 Island Not Intended for Bather Use If the ISLAND is not designed for BATHER use, warning signs stating "No Entry" shall be required.

4.8.1.7.6 Bridge or Stairway An ISLAND designed for BATHER traffic shall be accessible by bridge, ramp, ladder, or stairway from the POOL.

4.8.1.7.7 Minimum Clearance All bridges spanning a POOL or any other structures not intended for INTERACTIVE PLAY shall have a minimum clearance of 7 feet (2.1 m) from the bottom of the POOL to any structure overhead.

4.8.1.7.8 Guard Rails Any bridge shall have a minimum 42 inch (1.1 m) high BARRIER on both sides.

4.8.1.8[A] Heated Decks

4.8.1.8.1 Freeze Protection Where heated DECKS are provided for the purpose of freeze protection, the extent of heated area shall minimally include the entire required PERIMETER DECK and required CIRCULATION PATH(S).

4.8.1.8.2 Clearly Delineated Heated DECK paths shall be clearly delineated with respect to un- heated DECKS.

4.8.1.9 Hose Bibbs

4.8.1.9.1 General Domestic water hose bibbs shall be provided in sufficient quantity, spacing, and type to wash down PERIMETER DECK and POOL DECK areas using a hose of no longer than 100 feet (30.5 m).

4.8.1.9.2 Backpressure Prevention All hose bibbs shall be equipped with BACKPRESSURE prevention devices.

4.8.2 Diving Boards and Platforms

4.8.2.1[A] Diving Envelope

4.8.2.1.1[A] Competitive Diving Diving boards shall be permitted only when the diving envelope conforms to the most current version of STANDARDS referenced in MAHC Chapter 3 for the certifying agency that regulates competitive diving at the AQUATIC FACILITY. Such certifying agencies include:

1) NCAA,
2) NFHS,
3) World Aquatics, or
4) U.S.A. Diving, Inc.

4.8.2.1.2[A] Non-Competitive Diving If the AQUATIC VENUE does not have competitive diving, then the diving envelope shall conform to the diving envelope STANDARDS of:

1) MAHC Table 4.8.2.2,
2) MAHC Table 4.8.2.3,
3) MAHC Figure 4.8.2.2.1, and
4) MAHC Figure 4.8.2.2.2.

4.8.2.2[A] Steps and Guardrails

4.8.2.2.1 Higher than Twenty-One Inches Diving stands higher than 21 inches (53.3 cm) measured from the DECK to the top of the butt end of the board or platform shall have steps or a ladder and handrails.

4.8.2.2.2 Self-Draining Treads Steps or ladder treads shall be self-draining, corrosion resistant, SLIP RESISTANT, and designed to support the maximum expected load.

4.8.2.2.3 Short Platforms Diving stands or platforms that are 1 meter (3.4 ft) or higher shall be protected with guard rails at least 30 inches (76.2 cm) above the board, extending at least to the edge of the water along with intermediate rails.

4.8.2.2.4[A] Tall Platforms Diving stands or platforms that are 2 meters (6.6 ft) or higher shall have guard rails with the top rail at least 36 inches (0.9 m) above the board and a second rail approximately half the distance from the platform to the upper rail.

Table 4.8.2.2: Diving Board Height and Dimensions

Diving Board Height	1.64 ft. (0.5 m)	2.46 ft. (0.75 m)	3.28 ft. (1.0 m)	3.84 ft. (3.0 m)
Diving Board Length	10.0 ft. (3.05 m)	12.0 ft. (3.66 m)	16.0 ft. (4.88 m)	16.0 ft. (4.88 m)
Diving Board Width	20.0 in. (50.8 cm)	20.0 in. (50.8 cm)	20.0 in. (50.8 cm)	20.0 in. (50.8 cm)

Table 4.8.2.3: Minimum Dimensions of Components Related to Diving Wells by Diving Board Height

**Letters refer to MAHC Figures 4.8.2.2.1 & 4.8.2.2.2*

Ref*	Diving Board Height	Minimum Dimension 0.5 Meter	Minimum Dimension 0.75 Meter	Minimum Dimension 1.0 Meter	Minimum Dimension 3.0 Meters
A	Distance from plummet back to pool wall	3.0 ft. *(0.91 m)*	4.5 ft. *(1.37 m)*	6.0 ft. *(1.83 m)*	6.0 ft. *(1.83 m)*
B	Distance from plummet to pool wall at side	10.0 ft. *(3.05 m)*	10.0 ft. *(3.05 m)*	10.0 ft. *(3.05 m)*	11.5 ft. *(3.51 m)*
C	Distance from plummet to adjacent plummet	8.83 ft. *(2.69 m)*	8.83 ft. *(2.69 m)*	8.83 ft. *(2.69 m)*	8.54 ft. *(2.60 m)*
D	Distance from plummet to pool wall ahead	26.0 ft. *(7.92 m)*	27.83 ft. *(8.48 m)*	29.58 ft. *(9.02 m)*	33.67 ft. *(10.26 m)*
E	Height, diving board to ceiling at plummet & distances F and G	16.0 ft. *(4.88 m)*	16.0 ft. *(4.88 m)*	16.0 ft. *(4.88 m)*	16.0 ft. *(4.88 m)*

Ref*	Diving Board Height	Minimum Dimension 0.5 Meter	Minimum Dimension 0.75 Meter	Minimum Dimension 1.0 Meter	Minimum Dimension 3.0 Meters
F	Clear overhead distance behind and each side of plummet	8.0 ft. *(2.34 m)*	8.0 ft. *(2.34 m)*	8.0 ft. *(2.34 m)*	8.0 ft. *(2.34 m)*
G	Clear overhead distance ahead of plummet	16.0 ft. *(4.88 m)*	16.0 ft. *(4.88 m)*	16.0 ft. *(4.88 m)*	16.0 ft. *(4.88 m)*
H	Depth of water at plummet	9.5 ft. *(2.90 m)*	10.75 ft. *(3.28 m)*	12.0 ft. *(3.66 m)*	12.5 ft. *(3.81 m)*
J	Distance ahead of plummet to depth K	12.0 ft. *(3.66 m)*	14.25 ft. *(4.34 m)*	16.5 ft. *(5.03 m)*	19.75 ft. *(6.02 m)*
K	Depth at distance J ahead of plummet	8.75 ft. *(2.67 m)*	10.0 ft. *(3.05 m)*	11.28 ft. *(3.44 m)*	12.17 ft. *(3.71 m)*
L	Distance at each side of plummet to depth M	8.0 ft. *(2.34 m)*	8.13 ft. *(2.48 m)*	8.25 ft. *(2.51 m)*	9.92 ft. *(3.02 m)*
M	Depth at distance L on each side of plummet	9.08 ft. *(2.77 m)*	10.33 ft. *(3.15 m)*	11.63 ft. *(3.54 m)*	12.17 ft. *(3.71 m)*
N	Maximum slope to reduce height E	30°	30°	30°	30°
P	Maximum floor slope to reduce depth ahead of K, to the sides of M, or back to pool wall behind H	3:1	3:1	3:1	3:1

Figure 4.8.2.2.1: Diving Platform Longitudinal Section: Side View

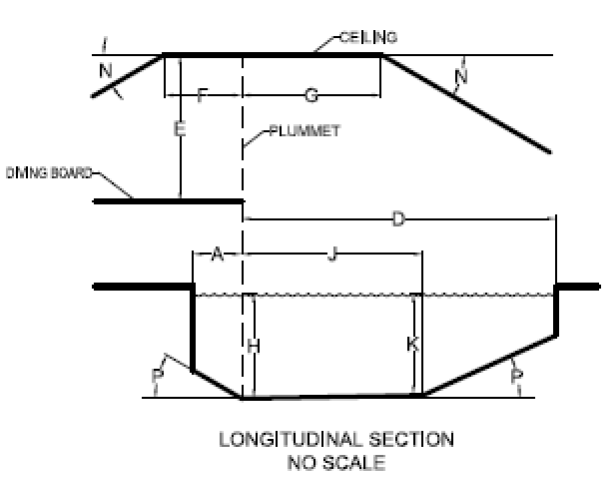
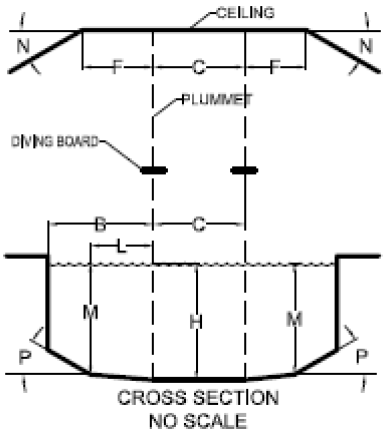


Figure 4.8.2.2.2: Diving Platform Cross Section: Front View



4.8.3 Starting Platforms

4.8.3.1A Conform to Standard Codes Starting platforms shall be installed and conform to applicable SAFETY STANDARDS established by:

1) World Aquatics,
2) U.S.A. Swimming,
3) NCAA,
4) NFHS,
5) YMCA, or
6) Other sanctioning body.

4.8.3.2 Minimum Water Depth Starting platforms shall be installed in a minimum water depth of 4 feet (1.25 m), except for new construction, where starting platforms shall be installed in a minimum water depth of 6 feet (1.8 m).

4.8.3.3 Leading Edge The leading edge of starting platforms shall have a maximum height of 30 inches (76.2 cm) above the water surface.

4.8.3.4 Slip Resistant Starting platforms shall have SLIP-RESISTANT tread surfaces.

4.8.3.5 Secure and Stable Starting platforms shall be installed and secured per manufacturer's recommendations at all times when in use.

4.8.4 Pool Slides [N/A]

4.8.5 Lifeguard- & Safety-Related Equipment

4.8.5.1 Equipment Inspection and Maintenance [N/A]

4.8.5.2 Safety Equipment Required at all Aquatic Facilities

4.8.5.2.1[A] Emergency Communication Equipment The AQUATIC FACILITY or each AQUATIC VENUE, as necessary, shall have a functional telephone or other communication device that is hard wired and capable of directly dialing 911 or function as the emergency notification system.

4.8.5.2.1.1 Conspicuous and Accessible The telephone or communication system or device shall be conspicuously provided and accessible to AQUATIC VENUE users such that it can be reached immediately.

4.8.5.2.1.2 Alternate Communication Systems Alternate systems, devices, or communication processes are allowed with approval of the AHJ in situations when a telephone is not logistically sound, and an alternate means of communication is available, which meet the requirements of MAHC 5.8.5.2.1.2.

4.8.5.2.1.3 Internal Communication The AQUATIC FACILITY design shall include a method for staff to communicate in cases of emergency.

4.8.5.2.1.4 Signage A sign shall be posted at the telephone providing dialing instructions, address and location of the AQUATIC VENUE location, and the telephone number.

4.8.5.3 Safety Equipment Required at Facilities with Lifeguards

4.8.5.3.1[A] Lifeguard Chair and Stand Placement The designer shall coordinate with the owner and/or an aquatic consultant to consider the impact on BATHER surveillance zones for placement of chairs and stands designed to be permanently installed to provide an unobstructed view of the BATHER surveillance zones.

4.8.5.3.2[A] Lifeguard Chair and Stand Design The chairs/stands shall be designed:

1) With no sharp edges or protrusions;
2) With sturdy, durable, and UV–resistant materials;
3) To provide enough height to elevate the lifeguard to an eye level above the heads of the BATHERS; and
4) To provide safe access and egress for the lifeguard.

4.8.5.3.3[A] UV Protection for Chairs and Stands Where provided, permanently installed chairs/stands, where QUALIFIED LIFEGUARDS can be exposed to UV radiation, shall include protection from such UV radiation exposure.

4.8.6 Enclosures and Barriers

4.8.6.1[A] General Requirements

4.8.6.1.1 Enclosure All AQUATIC FACILITIES, CHEMICAL STORAGE SPACES, and AQUATIC VENUE mechanical spaces shall be located in an ENCLOSURE to prevent unauthorized entry.

4.8.6.1.1.1 Enclosures The ENCLOSURE may consist of any combination of building envelopes, site walls, or fencing as provided for in this section.

4.8.6.1.1.2 Patron Accessibility An ENCLOSURE shall be provided between CHEMICAL STORAGE SPACES, POOL, mechanical spaces, and areas accessible to the public, in accordance with applicable local, state, territorial, federal, and tribal building CODES.

4.8.6.2 Construction Requirements

4.8.6.2.1[A] Discourage Climbing ENCLOSURES shall be designed to discourage climbing and be located at an AQUATIC VENUE or an AQUATIC FACILITY to prevent access to nearby structures to simplify climbing over it, such as light poles, site furnishings, overhanging tree limbs or other obvious footholds or handholds.

4.8.6.2.1.1 Horizontal Mid-Rails Horizontal mid-rails shall not be permitted.

4.8.6.2.1.2 Mesh Fencing Chain-link fencing constructed of a 1¼ inches (31.7 mm) mesh and limiting the maximum opening to 1 ¾ inches (44.4 mm) mesh shall be permitted.

4.8.6.2.2[A] Emergency Exit Paths ENCLOSURES for AQUATIC VENUES shall not block or encumber a required emergency egress path from other structures.

4.8.6.2.2.1 Pathways Where a required emergency egress path enters an area occupied by an outdoor AQUATIC VENUE, emergency exit pathways from the building(s) shall continue on DECK of least equally unencumbered width and continue to the ENCLOSURE and through gates.

4.8.6.2.2.2 Exit Pathways Exit pathways shall be separated with a BARRIER from AQUATIC VENUES not in operation.

4.8.6.2.2.3 Seasonal Separation Seasonal separation may be employed at seasonally operated AQUATIC VENUES, but shall be subject to the same physical requirements of permanent ENCLOSURES for AQUATIC VENUES in MAHC 4.8.6.

4.8.6.2.3 Windows Windows on a building that forms part of an ENCLOSURE around an AQUATIC VENUE shall have a maximum opening width not to exceed 4 inches (10.2 cm).

4.8.6.2.3.1 Opened If designed to be opened, windows shall also be provided with a non-removable screen.

4.8.6.2.4[A] Height AQUATIC FACILITY ENCLOSURES shall be no less than 6 feet (1.83 m) in height.

4.8.6.2.4.1 Change in Grade Where a change in grade occurs at an ENCLOSURE, height shall be measured from the uppermost grade to the top of the ENCLOSURE.

4.8.6.2.4.2 Fencing Requirements Height shall be measured from the finished grade to the top of the ENCLOSURE on the side outside of the ENCLOSURE surrounding an AQUATIC VENUE.

4.8.6.2.4.3[A] Other Barriers Not Serving as Part of an Enclosure Except where otherwise noted, all other BARRIERS not serving as part of an AQUATIC FACILITY ENCLOSURE shall not be less than 42 inches (1.1 m) in height.

4.8.6.2.5 Clearance Above Grade The maximum vertical clearance at the bottom of the AQUATIC VENUE OR AQUATIC FACILITY ENCLOSURE when measured on the side of the ENCLOSURE facing away from the enclosed space, shall not exceed:

1) 2 inches (5.1 cm) above grade when the ENCLOSURE rests on a non-solid surface, including grass or gravel or
2) 4 inches (10.2 cm) above grade when the ENCLOSURE rests on a solid surface.

4.8.6.3[A] Gates and Doors

4.8.6.3.1 Self-Closing and Latching All primary public access gates or doors serving as part of an AQUATIC FACILITY ENCLOSURE or required AQUATIC VENUE ENCLOSURE shall be self-closing and self-latching from any open position.

4.8.6.3.1.1[A] Self-latching Device Height Operable parts of the release latch on self-latching devices shall be located 4.5 feet (1.4 m) above finished grade.

4.8.6.3.1.2 Operable by Children Self-latching devices shall not be operable by small children on the outside of the ENCLOSURE around the AQUATIC VENUE.

4.8.6.3.1.3 Locked All gates or doors shall be capable of being locked from the exterior.

4.8.6.3.1.4 Emergency Egress Gates or doors shall be designed in such a way that they do not prevent egress in the event of an emergency.

4.8.6.3.1.5 Unauthorized Entry EXIT GATES or doors shall be constructed so as to prevent unauthorized entry from outside of the ENCLOSURE around the AQUATIC VENUE.

4.8.6.3.1.6[A] Exceptions

4.8.6.3.1.6.1 Exception 1: Staffed Entry When the gate or door of an AQUATIC FACILITY or AQUATIC VENUE ENCLOSURE is part of a staffed entrance and is locked at all times the AQUATIC FACILITY or AQUATIC VENUE is not open to the public.

4.8.6.3.1.6.2 Exception 2: Lifeguard(s) Provided When the gate or door serves as part of an AQUATIC FACILITY or AQUATIC VENUE ENCLOSURE and the AQUATIC VENUE(S) therein has a QUALIFIED LIFEGUARD(S) conducting PATRON surveillance at all times the AQUATIC VENUE(S) is open and the gate or door is locked at all times the AQUATIC FACILITY or AQUATIC VENUE is not open to the public.

4.8.6.3.2 Gates Gates shall be at least equal in height at top and bottom to the ENCLOSURE of which they are a component.

4.8.6.3.3 Turnstiles Turnstiles shall not form a part of an AQUATIC FACILITY ENCLOSURE.

4.8.6.3.4 Exit Gates EXIT GATES shall be conspicuously marked on the inside of the AQUATIC VENUE or AQUATIC FACILITY.

4.8.6.3.4.1 Quantity, Location, and Width Quantity, location, and width(s) for EXIT GATES shall be provided consistent with all applicable local, state, territorial, federal, and tribal building and fire CODES and applicable accessibility guidelines.

4.8.6.3.5 Swing Outward EXIT GATES shall swing away from the AQUATIC VENUE ENCLOSURE except where emergency egress CODES require them to swing into the AQUATIC VENUE ENCLOSURE.

4.8.6.3.6 Absence of Building Codes Where local, state, territorial, federal, and tribal building CODES do not otherwise govern, at least one 36-inch (91.4 cm) wide EXIT GATE shall be required for emergency access to each logical AQUATIC VENUE area including individual POOLS or grade levels or both.

4.8.6.4 Indoor Aquatic Venues

4.8.6.4.1 Enclosure Building walls enclosing an INDOOR AQUATIC FACILITY may be designated as the AQUATIC FACILITY ENCLOSURE.

4.8.6.4.2 Securable Indoor AQUATIC VENUES shall be securable from unauthorized entry from other building areas or the exterior.

4.8.6.4.3[A] Indoor and Outdoor Aquatic Venues Where separate indoor and outdoor AQUATIC VENUES are located on the same site, an AQUATIC VENUE ENCLOSURE shall be provided between them.

4.8.6.4.3.1 Year-Round Operation Exception: Where all AQUATIC VENUES are operated continuously 12 months a year on the same schedule.

4.8.6.4.4[A] Wall Separating For a passage through a wall separating the indoor portion of an AQUATIC VENUE from an outdoor portion of the same AQUATIC VENUE, the overhead clearance of the passage to the AQUATIC VENUE floor shall be at least 6 feet 8 inches (2.0 m) to any solid structure overhead.

4.8.6.5[A] Multiple Aquatic Venues

4.8.6.5.1 One Enclosure Except as otherwise required in this CODE, one ENCLOSURE may surround multiple AQUATIC VENUES at one facility.

4.8.6.5.2 Wading Pools WADING POOLS shall not require separation from other WADING POOLS by a BARRIER. Refer to MAHC 4.12.9 for additional guidance about WADING POOLS.

4.8.7[A] Aquatic Venue Cleaning Systems

4.8.7.1[A] No Hazard The cleaning system provided shall not create an entanglement or suction entrapment hazard or interfere with the operation or use of the AQUATIC VENUE.

4.8.7.2 Common Cleaning Equipment If there are multiple AQUATIC VENUES at one AQUATIC FACILITY, the AQUATIC FACILITY may use common cleaning equipment.

4.8.7.3 Integral Vacuum Systems Use of integral vacuum systems, meaning a vacuum system that uses the main circulating pump or a dedicated vacuum pump connect to the POOL with PVC piping and terminating at the POOL with a flush-mounted vacuum port fitting, shall be prohibited.

4.8.7.4 GFCI Power Where used, PORTABLE VACUUM cleaning equipment shall be powered by circuits having GROUND-FAULT CIRCUIT INTERRUPTERS.

4.8.7.5 Low Voltage Any ROBOTIC CLEANERS shall utilize low voltage for all components that are immersed in the POOL water.

4.8.7.6[A] GFCI Connection Any ROBOTIC CLEANER power supply shall be connected to a circuit equipped with a ground fault interrupter, and shall not be operated using an extension cord.

4.9 Filter/Equipment Room and Chemical Storage

4.9.1 Equipment Room

4.9.1.1[A] General Requirements

4.9.1.1.1 Nonabsorbent Material The EQUIPMENT ROOM OR AREA floor shall be of concrete or other suitable material having a smooth SLIP-RESISTANT finish.

4.9.1.1.1.1 Positive Drainage The EQUIPMENT ROOM OR AREA floor shall have positive drainage, including a sump drain pump if necessary.

4.9.1.1.2 Floor Slope Floors shall have a slope toward the floor drain and/or sump drain pump adequate to prevent standing water at all times.

4.9.1.1.3 Opening The opening to the EQUIPMENT ROOM OR AREA shall be designed to provide access for all anticipated equipment.

4.9.1.1.4 Hose Bibb At least one hose bibb with BACKPRESSURE preventer shall be located in the EQUIPMENT ROOM or be accessible within an adequate distance of the EQUIPMENT ROOM so that a hose can service the entire EQUIPMENT ROOM.

4.9.1.2[A] Construction

4.9.1.2.1 Size The size of the EQUIPMENT ROOM OR AREA shall provide working space to perform routine operations and equipment service.

4.9.1.2.1.1 Adequate Storage Space EQUIPMENT ROOMS also intended for STORAGE shall have adequate space provided for such STORAGE, without reducing the working spaces.

4.9.1.2.2 Lighting EQUIPMENT ROOMS or areas shall be lighted to provide 30 foot candles (323 lux) of illumination at floor level in accordance with IESNA guidelines.

4.9.1.3 Electrical

4.9.1.3.1 Conform to NEC All electrical wiring shall conform to the edition of NEC adopted by the AHJ.

4.9.1.3.2 Conform to NRTL Equipment, components, and their application and installation shall conform to the NRTL listing.

4.9.1.4[A] Ventilation

4.9.1.4.1 Code Conformance EQUIPMENT ROOM ventilation shall address:

1) COMBUSTION requirements,
2) Heat dissipation from equipment,
3) Humidity from surge or balance tanks,
4) Ventilation to the outside, and
5) Air quality.

4.9.1.5[A] Markings

4.9.1.5.1 Piping Identified All piping in the EQUIPMENT ROOM shall be permanently identified by its use and the AQUATIC VENUE and AQUATIC FEATURE it serves.

4.9.1.5.1.1 Components to Identify Identification shall be provided for:

1) Main drains and SKIMMERS,
2) Filtered water,
3) Make-up water,
4) Backwash water,
5) Chlorine (or DISINFECTION) feeds,

6) Acid (or pH) feeds,

7) Compressed air lines,

8) Gutters,

9) Chemical sample piping, and

10) POOL heating lines.

4.9.1.5.2 Piping Marked All piping shall be marked with directional arrows as necessary to determine flow direction.

4.9.1.5.3 Valves Identified All valves shall be clearly identified by number with a brass tag, plastic laminate tags, or permanently affixed alternate.

4.9.1.5.3.1 Valves Described Valves shall be described as to their function and referenced in the operating instruction manual.

4.9.1.5.3.2 Piping Diagram A water-resistant, easily read, wall-mounted piping diagram shall be furnished and installed inside the EQUIPMENT ROOM.

4.9.1.6[A] Equipment Rooms Containing Combustion Equipment [N/A]

4.9.1.7[A] Separation from Chemical Storage Spaces

4.9.1.7.1 Equipment

4.9.1.7.1.1[A] Contaminated Air Combustion equipment, air-handling equipment, and electrical equipment shall not be exposed to air contaminated with corrosive chemical fumes or vapors.

4.9.1.7.1.2[A] Equipment Restrictions Spaces containing combustion equipment, air handling equipment, and/or electrical equipment and spaces sharing air distribution with spaces containing such equipment shall not be used as CHEMICAL STORAGE SPACES at the same time.

4.9.1.7.1.2.1 Certified, Listed, and Labeled Exception: Equipment CERTIFIED, LISTED, AND LABELED for use in that atmosphere shall be acceptable.

4.9.1.7.1.3[A] Isolated Spaces containing combustion equipment, air-handling equipment, and/or electrical equipment and spaces sharing air distribution with spaces containing such equipment shall be isolated from CHEMICAL STORAGE SPACE air.

4.9.1.7.2 Doors and Openings

4.9.1.7.2.1[A] Between Equipment and Chemical Storage A door or doors shall not be installed in a wall between such EQUIPMENT ROOMS and an interior CHEMICAL STORAGE SPACE.

4.9.1.7.2.2[A] No Openings There shall be no ducts, grilles, pass-throughs, or other openings connecting such EQUIPMENT ROOMS to CHEMICAL STORAGE SPACES, except as permitted by the fire CODE.

4.9.1.7.2.3[A] Indoor Aquatic Facility Air Spaces containing combustion equipment, air-handling equipment, and/or electrical equipment and spaces sharing air distribution with spaces containing such equipment shall be isolated from INDOOR AQUATIC FACILITY air.

4.9.1.7.2.3.1 Certified, Listed, and Labeled Equipment Exception: Equipment CERTIFIED, LISTED, AND LABELED for the atmosphere shall be acceptable.

4.9.1.7.2.4[A] No Openings There shall be no ducts, grilles, pass-throughs, or other openings connecting such spaces to an INDOOR AQUATIC FACILITY.

4.9.1.7.2.4.1 Air Handlers Ducts which connect the INDOOR AQUATIC FACILITY to the duct connections of air handlers shall not be construed as connecting the air-handler space to the INDOOR AQUATIC FACILITY.

4.9.1.7.2.4.2 HVAC Equipment Exception: HVAC equipment which is rated for INDOOR AQUATIC FACILITY atmosphere and which serves only that INDOOR AQUATIC FACILITY shall be acceptable.

4.9.1.7.2.5[A] Openings / Gaps Where building construction leaves any openings or gaps between floors and walls, or between walls and other walls, or between walls and ceilings, such gaps shall be permanently sealed against air leakage.

4.9.1.7.3 Indoor Aquatic Facility Access

4.9.1.7.3.1[A] Floor Slope Where a door or doors must be installed in a wall between an EQUIPMENT ROOM and an INDOOR AQUATIC FACILITY, the floor of the EQUIPMENT ROOM shall slope per all applicable local, state, territorial, federal, and tribal building requirements back into the EQUIPMENT ROOM in such a way as to prevent any EQUIPMENT ROOM spills from running under the door into the INDOOR AQUATIC FACILITY.

4.9.1.7.3.1.1 Four Inches Exception: This requirement may be met by a floor all of which is at least 4 inches (10.2 cm) below the level of the nearest part of the INDOOR AQUATIC FACILITY floor.

4.9.1.7.3.1.2 Dike Exception: This requirement may be met by a continuous dike not less than 4 inches (10.2 cm) high located entirely within the EQUIPMENT ROOM, which will prevent spills from reaching the INDOOR AQUATIC FACILITY floor.

4.9.1.7.3.1.3 Floor Drains EQUIPMENT ROOM floor drains may be required by the AHJ.

4.9.1.7.3.2[A] Automatic Closer Such door or doors between an EQUIPMENT ROOM and an INDOOR AQUATIC FACILITY shall be equipped with an automatic closer.

4.9.1.7.3.2.1 Maintained to Close Reliably The door, frame, and automatic closer shall be installed and maintained so as to ensure that the door closes completely and latches without human assistance.

4.9.1.7.3.3[A] Automatic Lock Such door or doors between an EQUIPMENT ROOM and an INDOOR AQUATIC FACILITY shall be equipped with an automatic lock.

4.9.1.7.3.3.1[A] Restrict Access Such lock shall require a key or combination to open from the INDOOR AQUATIC FACILITY side.

4.9.1.7.3.3.2 One Hand Such lock shall be so designed and installed as to be opened by one hand from the inside of the room under all circumstances, without the use of a key or tool.

4.9.1.7.3.4 Warning Sign Such doors shall be equipped with permanent signage warning against unauthorized entry.

4.9.1.7.3.5 Gasket All sides of such doors shall be equipped with a gasket.

4.9.1.7.3.5.1 Prevent Air Passage The gasket shall be so installed as to prevent the passage of air, fumes, or vapors when the door is closed.

4.9.1.7.3.6 Not Relief This section shall not be construed as granting relief from MAHC 4.9.1.7.2.1.

4.9.1.8 Other Equipment Room Guidance

4.9.1.8.1[A] Access Space Where ventilation, air filtration, or space dehumidification, heating, or cooling for an INDOOR AQUATIC FACILITY is by mechanical equipment located in an EQUIPMENT ROOM, adequate access space shall be provided to allow for inspection and service.

4.9.1.8.1.1[A] Size Requirements The access spaces shall be the greater of:

1) Those required by OSHA, NEC, National Fuel Gas Code, or other official requirements or
2) The equipment manufacturers' recommendations.

4.9.1.8.2[A] Adequate Space Where ventilation, air filtration, or space heating or cooling for an INDOOR AQUATIC FACILITY is beside mechanical equipment located in an EQUIPMENT ROOM, adequate space for required straight lengths of duct shall be provided as the greater of those described in AMCA 201, SMACNA Duct Manual, ACCA Manual SPS Sec. 13, or the equipment manufacturer's recommendations.

4.9.1.8.3[A] Minimize Hazards Where an EQUIPMENT ROOM contains equipment requiring regular service or maintenance, the room shall be so designed and constructed as to minimize the hazards of such maintenance and service.

4.9.1.8.3.1 Ladder Installed Where a ladder will be required for service or maintenance of equipment, other permanently installed equipment shall not be so located as to interfere with the use of the ladder.

4.9.1.8.3.2 Alternative Access Where a ladder cannot be safely or practically used to service equipment where any serviceable component is more than 6.5 feet (2.0 m) above the floor, a mezzanine floor, platform, or other arrangement for safe access shall be provided.

4.9.1.8.3.2.1 Exception: Where otherwise specifically allowed by OSHA.

4.9.1.8.3.2.2 Stricter Requirements Exception: Where OSHA or other applicable CODES or STANDARDS have stricter requirements, those stricter requirements shall prevail.

4.9.1.8.4[A] Refrigeration Equipment Where refrigeration equipment such as an air-conditioner or dehumidifier is located indoors in a building intended for occupation, arrangements for refrigerant relief (if any) shall be according to the applicable mechanical CODE or other applicable CODE.

4.9.2[A] Chemical Storage Spaces Nothing in this section shall be construed as providing relief from applicable requirements of fire CODES, mechanical CODES, electrical CODES, etc.

4.9.2.1 Outdoor / Indoor Storage

4.9.2.1.1 Stored Outdoors If POOL chemicals, acids, salt, oxidizing cleaning materials, or other corrosive or oxidizing chemicals are STORED outdoors, they shall be stored in a well-ventilated protective area with an installed ENCLOSURE to prevent unauthorized access as per MAHC 4.9.2.3.

4.9.2.1.2 Minimize Vapors Where such materials must be stored in a building intended for occupancy, the transfer of chemical fumes and vapors from the CHEMICAL STORAGE SPACE to other parts of the building shall be minimized.

4.9.2.1.3[A] Dedicated Space At least one space dedicated to CHEMICAL STORAGE SPACE shall be provided to allow safe STORAGE of the chemicals present.

4.9.2.1.4[A] Eyewash In all CHEMICAL STORAGE SPACES in which POOL chemicals will be STORED, an emergency eyewash station shall be provided.

4.9.2.2[A] Construction

4.9.2.2.1 Foreseeable Hazards The construction of the CHEMICAL STORAGE SPACE shall take into account the foreseeable hazards.

4.9.2.2.2 Protected The construction of the CHEMICAL STORAGE SPACE shall, to the extent practical, protect the STORED materials against tampering, incompatible chemicals and materials, high humidity, unintended exposure to water, direct sunlight, sources of ignition, and temperature extremes (i.e. 32°F [0°C] and below and/or over 95°F [35°C]).

4.9.2.2.3[A] Floor The floor or DECK of the CHEMICAL STORAGE SPACE shall be protected against substantial chemical damage.

4.9.2.2.4 Minimize Fumes The construction and operation of a CHEMICAL STORAGE SPACE shall minimize the transfer of chemical fumes into any INTERIOR SPACE of a building intended for occupation.

4.9.2.2.5 Surfaces Any walls, floors, doors, ceilings, and other building surfaces of an interior CHEMICAL STORAGE SPACE shall join each other tightly.

4.9.2.2.6[A] No Openings There shall be no permanent or semi-permanent opening between a CHEMICAL STORAGE SPACE and any other INTERIOR SPACE of a building intended for occupation unless compliant with MAHC 4.9.2.4.3, 4.9.2.4.4, and 4.9.2.4.5.

4.9.2.3[A] Exterior Chemical Storage Spaces

4.9.2.3.1 Outdoor Equipment Equipment listed for outdoor use may be located in an exterior CHEMICAL STORAGE SPACES as permitted.

4.9.2.3.2[A] Enclosure Exterior CHEMICAL STORAGE SPACES not joined to a wall of a building shall have a complete ENCLOSURE consisting of fencing or other similar constructed feature that is at least 6 feet (1.8 m) high and meets the non-climbability requirements of MAHC 4.8.6.2.1.

4.9.2.3.3 Gate Fencing shall be equipped with a self-closing and self-latching gate having a permanent locking device.

4.9.2.4[A] Chemical Storage Space Doors

4.9.2.4.1[A] Signage All doors opening into CHEMICAL STORAGE SPACES shall be equipped with permanent signage:

1) Warning against unauthorized entry,
2) Specifying the expected hazards,
3) Specifying the location of the associated SDS forms, and
4) Product chemical hazard NFPA chart.

4.9.2.4.2[A] Emergency Egress Where a single door is the only means of egress from a CHEMICAL STORAGE SPACE, the door shall be equipped with an emergency-egress device.

4.9.2.4.3[A] Interior Door Where a CHEMICAL STORAGE SPACE door must open to an INTERIOR SPACE, spill containment shall be provided to prevent spilled chemicals from leaving the CHEMICAL STORAGE SPACE.

4.9.2.4.4[A] Equipment Space Where a CHEMICAL STORAGE SPACE door must open to an INTERIOR SPACE, the door shall not open to a space containing combustion equipment, air-handling equipment, or electrical equipment.

4.9.2.4.4.1[A] Corrosive Such door shall be acceptable where all equipment thus exposed is listed for the corrosive atmosphere.

4.9.2.4.5 Interior Opening Where a CHEMICAL STORAGE SPACE door must open to an INTERIOR SPACE, such door shall have all of the following requirements outlined from MAHC 4.9.2.4.5.1 to 4.9.2.4.5.7.2.

4.9.2.4.5.1 Corrosion Resistant Such doors shall be constructed of corrosion-resistant materials.

4.9.2.4.5.2[A] Automatic Lock Such doors shall be equipped with a corrosion-resistant, automatic lock to prevent unauthorized entry.

4.9.2.4.5.2.1 Key or Combination Such lock shall require a key or combination to open from the outside into the CHEMICAL STORAGE SPACE.

4.9.2.4.5.2.2 Opened Such lock shall be so designed and installed as to be capable of being opened by one hand from the inside of the CHEMICAL STORAGE SPACE without the use of a key or tool.

4.9.2.4.5.3 Supported Such doors shall be supported on corrosion-resistant hinges, tracks, or other supports.

4.9.2.4.5.4 Air Leakage Such doors shall be equipped with suitable gaskets or seals on the top and all sides to minimize air leakage between the door and the door frame.

4.9.2.4.5.5 Floor Such doors shall be equipped with a floor or threshold seal to minimize air leakage between the door and the floor or threshold.

4.9.2.4.5.6 Automatic Closer Such doors shall be equipped with an automatic door closer that will completely close the door and latch without human assistance.

4.9.2.4.5.6.1 Air Pressure The door closer shall be able to close the door completely against the specified difference in air pressure.

4.9.2.4.5.7 Limit Switch Such doors shall be equipped with a limit switch and an alarm that will sound if the door remains open for more than 30 minutes.

4.9.2.4.5.7.1 Alarm This alarm shall have a minimum output level of 85 dbA at 10 feet (3.0 m).

4.9.2.4.5.7.2 Loss of Air Pressure Where an open door will result in loss of air-pressure difference, this requirement can be met by the audible alarm required under MAHC 4.9.2.5.2.4.

4.9.2.5[A] Interior Chemical Storage Spaces

4.9.2.5.1[A] No Air Movement There shall be no transfer grille, pass-through grille, louver, or other device or opening that will allow air movement from the CHEMICAL STORAGE SPACE into any other INTERIOR SPACE of a building intended for occupancy or into another CHEMICAL STORAGE SPACE.

4.9.2.5.2[A] Electrical Conduit System Interior CHEMICAL STORAGE SPACES that share any building surface (wall, floor, ceiling, door, etc.) with any other INTERIOR SPACE shall be equipped with a ventilation system that operates continuously and ensures that all air movement is from all other INTERIOR SPACES and toward the CHEMICAL STORAGE SPACE.

4.9.2.5.2.1 Additional Interior Space Interior CHEMICAL STORAGE SPACES that share an electrical conduit system with any other INTERIOR SPACE shall be equipped with a ventilation system that operates continuously and ensures that all air movement is from all other INTERIOR SPACES and toward the CHEMICAL STORAGE SPACE.

4.9.2.5.2.2[A] Pressure Difference This pressure difference shall be maintained by a continuously operated exhaust system used for no other purpose than to remove air from that one CHEMICAL STORAGE SPACE.

4.9.2.5.2.3 Separate Exhaust System Where more than one CHEMICAL STORAGE SPACE is present, a separate exhaust system shall be provided for each CHEMICAL STORAGE SPACE.

4.9.2.5.2.3.1 Airflow Rate The exhaust airflow rate shall be the greater of the:

1) OSHA requirements for working in such enclosed spaces,
2) Amount needed to maintain the concentration of vapors or fumes below the PEL for the expected exposure time (defined by 29 CFR 1910.1000 [OSHA]) for each stored chemical,
3) Amount specified by International Mechanical Code,
4) Amount specified by the Uniform Mechanical Code, or
5) Amount needed to maintain the specified pressure difference.

4.9.2.5.2.4[A] Alarm The function of this exhaust system shall be MONITORED continuously by an audible differential-pressure alarm system which shall sound if the specified differential air pressure is not maintained for a period of 30 minutes.

4.9.2.5.2.4.1 Minimum Output This alarm shall have a minimum output level of 85 dbA at 10 feet (3.0 m).

4.9.2.5.2.4.2 Manual Reset The specified alarm shall require manual reset to silence it.

4.9.2.6 Air Ducts in Interior Chemical Storage Spaces

4.9.2.6.1[A] No Air Movement No duct shall allow air movement from the CHEMICAL STORAGE SPACE into any other INTERIOR SPACE of a building intended for occupation or into any other CHEMICAL STORAGE SPACE.

4.9.2.6.2 Chemical Storage Air ducts shall not enter or pass through an interior CHEMICAL STORAGE SPACE.

4.9.2.6.2.1 Corrosion Resistant Exception: A corrosion-resistant duct used for no other purpose than to exhaust air from the CHEMICAL STORAGE SPACE shall be acceptable.

4.9.2.6.2.1.1 Building Exterior This corrosion-resistant duct shall exhaust to the exterior and must end at a point on the exterior of the building, at least 20 feet (6.1 m) from any air intake for breathing air, cooling air, or combustion air.

4.9.2.6.2.2 Makeup Air Exception: A duct used for no other purpose than to supply makeup air to the CHEMICAL STORAGE SPACE shall be acceptable.

4.9.2.6.2.2.1 Building Exterior This makeup air supply duct shall end at a point on the exterior of the building, at least 20 feet (6.1 m) from any air intake for breathing air, cooling air, or combustion air.

4.9.2.6.2.3 Other Ducts Exception: Any other ducts specifically allowable by applicable building and mechanical CODES where such ducts are corrosion resistant and joint free to the extent feasible shall be acceptable.

4.9.2.7 Pipes and Tubes in Interior Chemical Storage Spaces

4.9.2.7.1 Not Enter Pipes and tubes shall not enter or pass through an interior CHEMICAL STORAGE SPACE.

4.9.2.7.1.1 Service Exception: As required to service devices integral to the function of the CHEMICAL STORAGE SPACE, such as pumps, vessels, controls, freeze protection, and safety devices.

4.9.2.7.1.2 Automatic Fire Suppression Exception: As required to allow for automatic fire suppression where required.

4.9.2.7.1.3 Drainage Exception: As required for drainage.

4.9.2.7.2 Devices Piping, tubes, drain bodies, grates, and attachment and restraint devices shall be corrosion resistant and rated for the chemical environment(s) present including floor drain bodies and grates.

4.9.2.7.3 Wall Penetrations All wall penetrations shall be sealed air-tight.

4.9.2.7.3.1 Rating All wall penetrations shall be commensurate with the rating of the wall assembly.

4.9.2.7.3.2 Sealing Materials Sealing material(s) shall be compatible with the wall assembly and the chemical environment(s) present.

4.9.2.8[A] Combustion Equipment in Interior Chemical Storage Spaces

4.9.2.8.1 Installed No COMBUSTION DEVICE or appliance shall be installed in a CHEMICAL STORAGE SPACE, or in any other place where it will be exposed to the air from a CHEMICAL STORAGE SPACE.

4.9.2.8.1.1 Exception: A COMBUSTION DEVICE or appliance which meets all of the following requirements shall be acceptable:

1) The device or appliance is required for one or more processes integral to the function of the room, such as space heat;
2) The device is listed for such use; and
3) The device as installed is acceptable to the AHJ.

4.9.2.9 Electrical Equipment in Chemical Storage Spaces Electrical equipment and wiring methods used for or in CHEMICAL STORAGE SPACES shall comply with MAHC 4.9.2.

4.9.2.10 Ozone Rooms

4.9.2.10.1 Only Ozone Equipment An ozone EQUIPMENT ROOM shall not be used for STORAGE of chemicals, solvents, or any combustible materials, other than those required for the operation of the recirculation and ozone generating equipment.

4.9.2.10.2 Emergency Ventilation Rooms which are designed to include ozone equipment shall be equipped with an emergency ventilation system capable of six air changes per hour.

4.9.2.10.2.1 Exhaust Intake The exhaust intake shall be located approximately 6 inches (15.2 cm) from the floor, on the opposite side of the room from the make-up air intake.

4.9.2.10.2.2 On Command The emergency ventilation system shall be so arranged as to run on command of an ozone-leak alarm or on command of a manual switch.

4.9.2.10.2.3 Manual Switch The manual emergency ventilation switch shall be located outside the room and near the door to the ozone room.

4.9.2.10.3 Below Grade Ozone rooms which are below grade shall be equipped with forced-draft ventilation capable of six air changes per hour.

4.9.2.10.3.1 Exhaust Intake The exhaust intake shall be located approximately 6 inches (15.2 cm) from the floor, on the opposite side of the room from the make-up air intake.

4.9.2.10.3.2 Arranged Such ventilation system shall be so arranged as to:

1) Run automatically concurrent with the ozone equipment and for at least a time allowing for 15 air changes after the ozone equipment is stopped,
2) Run upon activation of the ozone detection and alarm system, and
3) Run on command of a manual switch.

4.9.2.10.3.3 Manual Ventilation Switch The manual ventilation switch shall be located outside the room and near the door to the ozone room.

4.9.2.10.4 Signage In addition to the signs required on all CHEMICAL STORAGE SPACES, a sign shall be posted on the exterior of the entry door, stating “DANGER - GASEOUS OXIDIZER – OZONE” in lettering not less than 4 inches (10.2 cm) high.

4.9.2.10.5 Alarm System Rooms containing ozone generation equipment shall be equipped with an audible and visible ozone detection and alarm system.

4.9.2.10.5.1 Requirements The alarm system shall consist of both an audible alarm capable of producing at least 85 decibels at 10 feet distance (3.0 m), and a visible alarm consisting of a flashing light mounted in plain view of the entrance to the ozone-EQUIPMENT ROOM.

4.9.2.10.5.2 Sensor The ozone sensor shall be located at a height of 18–24 inches (45.7–61.0 cm)

above floor level.

4.9.2.10.5.2.1 Measuring The ozone sensor shall be capable of measuring the ozone concentration in the air in the range of 0–2 ppm by volume (ppmv or mL/m3).

4.9.2.10.5.3 Ozone Concentration The alarm system shall alarm when the ozone concentration equals or exceeds 0.1 ppm by volume (ppmv or mL/m3) in the room air.

4.9.2.10.5.4 Activation Activation of the alarm system shall shut off the ozone generating equipment and turn on the emergency ventilation system.

4.9.2.11[A] Gaseous Chlorination Space As per MAHC 4.7.3.2.4.1, use of compressed CHLORINE gas shall be prohibited for new construction and after SUBSTANTIAL ALTERATION to existing AQUATIC FACILITIES.

4.9.2.11.1 Existing Facilities MAHC 4.9.2.11 shall apply to existing facilities using compressed CHLORINE gas.

4.9.2.11.2 Adequate Size A gaseous-chlorination space shall be large enough to house the chlorinator, CHLORINE STORAGE tanks, and associated equipment as required.

4.9.2.11.3 Secure Tanks A gaseous-chlorination space shall be equipped with facilities for securing tanks.

4.9.2.11.4 Not Below Grade A gaseous-chlorination space shall not be located in a basement or otherwise be below grade.

4.9.2.11.5 Compressed-Chlorine Gas Where installed indoors, compressed-CHLORINE gas STORAGE containers and associated chlorinating equipment shall be in a separate room constructed to have a fire rating of not less than 1-hour.

4.9.2.11.6 Entry Door The entry door to an indoor gaseous-CHLORINE space shall open to the exterior of the building or structure.

4.9.2.11.6.1 Pool or Deck The entry door to an indoor gaseous-CHLORINE space shall not open directly towards a POOL or DECK.

4.9.2.11.7 Inspection Window An indoor gaseous-CHLORINE space shall be provided with a shatterproof gas-tight inspection window.

4.9.2.11.8 Ventilation Indoor gaseous-chlorination spaces shall be provided with a spark-proof ventilation system capable of 60 air changes per hour.

4.9.2.11.8.1 Exhaust-Air Intake The exhaust-air intake of the ventilation system shall be taken at a point within 6 inches (15.2 cm) of the floor, and on the opposite side of the room from the makeup-air intake.

4.9.2.11.8.2 Discharge Point The exhaust-air discharge point shall be:

1) Outdoors,
2) Above adjoining grade level,
3) At least 20 feet (6.1 m) from any operable window, and
4) At least 20 feet (6.1 m) from any adjacent building.

4.9.2.11.8.3 Make-Up Intake The make-up air intake shall be within 6 inches (15.2 cm) of the ceiling of the space.

4.9.2.11.8.3.1 Open Outdoors The make-up air intake shall open directly to the outdoors.

4.9.2.11.8.4 Personal Protective Equipment Available PPE, consisting of at least a gas mask approved by NIOSH for use with CHLORINE atmospheres, shall be stored directly outside one entrance to an indoor gaseous-chlorination space.

4.9.2.11.8.5 SCBA Systems A minimum of two SCBA systems shall be on hand at all times and two QUALIFIED OPERATORS are to be involved in the changing of the tanks.

4.9.2.11.8.6 Stationed Outside One of the QUALIFIED OPERATORS should be stationed outside of the chemical room where the QUALIFIED OPERATOR inside can be seen at all times.

4.9.2.11.8.7 Emergency Telephone An emergency direct line telephone shall be located by the door.

4.9.2.12 Windows in Chemical Storage Spaces

4.9.2.12.1[A] Not Required Windows in CHEMICAL STORAGE SPACES shall not be required by this CODE.

4.9.2.12.2[A] Requirements Where a window is to be installed in an interior wall, ceiling, or door of a CHEMICAL STORAGE SPACE, such window shall have the following components:

1) Tempered or plasticized glass,
2) A corrosion-resistant frame, and
3) Incapable of being opened or operated.

4.9.2.12.3 Exterior Window Any CHEMICAL STORAGE SPACE window in an exterior wall or ceiling shall:

1) Be mounted in a corrosion-resistant frame and
2) Be so protected by a roof, eave or permanent awning as to minimize the entry of rain or snow in the event of window breakage.

4.9.2.13 Sealing and Blocking Materials

4.9.2.13.1 Minimize Leakage Materials used for sealing and blocking openings in an interior CHEMICAL STORAGE SPACE shall minimize the leakage of air, vapors, or fumes from the CHEMICAL STORAGE SPACE.

4.9.2.13.2 Compatible Materials used for sealing and blocking openings in an interior CHEMICAL STORAGE SPACE shall be compatible for use in the environment.

4.9.2.13.3 Fire Rating Materials used for sealing and blocking openings in an interior CHEMICAL STORAGE SPACE shall be commensurate with the fire rating of the assembly in which they are installed.

4.10 Hygiene Facilities

4.10.1[A] General

4.10.1.1 New Construction or Substantial Alteration All design provisions shall be required for new construction or SUBSTANTIAL ALTERATION to an existing AQUATIC FACILITY.

4.10.1.1.1 At Time of Adoption Exception: The following MAHC sections shall be required for all AQUATIC FACILITIES at time of adoption or within 1 year of adoption as stated:

1) MAHC 4.10.4.5: Diaper-changing stations,
2) MAHC 4.10.4.6.5: Soap Dispensers, and
3) MAHC 4.10.4.6.9: Trash Can

4.10.1.2[A] Minimum to Provide AQUATIC FACILITIES shall provide HYGIENE FACILITIES that include, at a minimum, toilets, urinals, SHOWERS, DIAPER-CHANGING STATIONS, and other HYGIENE FIXTURES, as specified herein.

4.10.1.3 Construction HYGIENE facilities shall be constructed in accordance with all applicable local, state, territorial, federal, and tribal laws or as modified herein.

4.10.1.4 Minimum Toilets, Urinals, and Other Fixtures The minimum number of toilets, urinals, and other HYGIENE FIXTURES provided, excluding SHOWERS, shall be the greater of the following two options:

1) In accordance with all applicable local, state, territorial, federal, and tribal laws or
2) Based upon maximum theoretical peak occupancy of each aquatic venue.

4.10.1.5[A] Theoretical Peak Occupancy THEORETICAL PEAK OCCUPANCY for all AQUATIC VENUES shall be calculated as defined in MAHC 4.1.2.3.5.3.

4.10.2 Location

4.10.2.1[A] Distance Except as required in MAHC 4.10.2.2, a drinking fountain, toilet, HANDWASHING STATION, and DIAPER-CHANGING STATION shall be located no greater than 300 feet (91 m) walking distance from each AQUATIC VENUE.

4.10.2.2[A] Children Less than Five Years of Age An AQUATIC VENUE designed primarily for use by children less than 5 years of age shall have a drinking fountain, toilet, HANDWASHING STATION, and DIAPER- CHANGING STATION located no greater than 200 feet (61 m) walking distance and in clear view from the nearest entry/exit of the AQUATIC VENUE.

4.10.3[A] Design and Construction

4.10.3.1 Floors The floors of HYGIENE FACILITIES and dressing areas serving AQUATIC FACILITIES shall have a smooth, easily cleaned, impervious-to-water, SLIP-RESISTANT surface.

4.10.3.2[A] Floor Base A hard, smooth, impervious-to-water, easily cleaned base shall provide a sealed, coved juncture between the wall and floor and extend upward on the wall at least 6 inches (15.2 cm).

4.10.3.3 Floor Drains Floor drains shall be installed in HYGIENE FACILITIES and dressing areas where PLUMBING FIXTURES are located.

4.10.3.3.1[A] Opening Grill Covers Floor drain opening grill covers shall be ½-inch (1.3 cm) or less in width or diameter.

4.10.3.3.2[A] Sloped to Drain Floors shall be sloped to drain water or other liquids.

4.10.3.3.2.1 Accessible Routes Where DECK areas serve as ACCESSIBLE ROUTES or portions thereof, slopes in any direction shall not exceed ADA STANDARDS and MAHC 4.8.1.3.1.

4.10.3.4 Partitions and Enclosures Partitions and ENCLOSURES adjacent to HYGIENE FACILITIES shall have a smooth, easy-to-clean, impervious surface.

4.10.3.5[A] Hose Bibb At least one hose bibb or other potable water source capable of connecting a hose shall be located in each HYGIENE FACILITY to facilitate cleaning.

4.10.4[A] Plumbing Fixture Requirements

4.10.4.1 General

4.10.4.1.1[A] Protected PLUMBING FIXTURES shall be installed and operated in a manner to adequately protect the potable water supply from back siphonage or BACKPRESSURE in accordance with all applicable local, state, territorial, federal, and tribal laws.

4.10.4.1.2 Easily Cleaned PLUMBING FIXTURES shall be designed so that they may be readily and frequently cleaned, SANITIZED, and disinfected.

4.10.4.1.3[A] Toilet Counts Total toilet or urinal counts shall be in accordance with all applicable local, state, territorial, federal, and tribal laws or as modified herein.

4.10.4.1.4 Hand Wash Sink Handwashing sink counts shall be in accordance with all applicable local, state, territorial, federal, and tribal laws or as modified herein.

4.10.4.2[A] Cleansing Showers

4.10.4.2.1[A] Count The minimum number of CLEANSING SHOWERS shall be one per sex for AQUATIC FACILITIES less than 4000 square feet (372 m2) in collective AQUATIC VENUE surface area.

4.10.4.2.1.1 Additional Cleansing Showers An additional CLEANSING SHOWER per sex shall be added for each additional 4000 square feet (372 m2) of AQUATIC VENUE space or portion thereof.

4.10.4.2.2 Distributed CLEANSING SHOWERS shall be evenly distributed between sexes, as applicable.

4.10.4.2.3[A] Location CLEANSING SHOWERS shall be located in a HYGIENE FACILITY that is near the entrance and within clear view of the AQUATIC VENUE.

4.10.4.2.4[A] Enclosed Entryways to private or group CLEANSING SHOWER areas shall be enclosed by a door or curtain.

4.10.4.2.4.1 Doors SHOWER doors shall be of a smooth, hard, easy-to-clean material.

4.10.4.2.4.2 Curtains SHOWER curtains shall be of a smooth, easy-to-clean material.

4.10.4.2.5 Soap Dispenser CLEANSING SHOWERS shall be supplied with soap and a soap dispenser adjacent to the SHOWER.

4.10.4.2.6[A] Exemption AQUATIC VENUES located in lodging and residential settings shall be exempt from MAHC 4.10.4.2.

4.10.4.2.7 Maximum and Minimum Temperature CLEANSING SHOWERs running water shall be delivered at a temperature between 90 degrees F (32 degrees C) and 120 degrees F (49 degrees C).

4.10.4.3[A] Rinse Showers

4.10.4.3.1 Minimum and Location A minimum of one RINSE SHOWER shall be provided on the DECK near an entry point to the AQUATIC VENUE.

4.10.4.3.2 Temperature Water used for RINSE SHOWERS may be at ambient temperature.

4.10.4.3.3[A] Floor Sloped Floors of RINSE SHOWERS shall be sloped to drain wastewater away from the AQUATIC VENUE and meet applicable local, state, territorial, federal, and tribal laws.

4.10.4.3.4[A] Large Aquatic Facilities RINSE SHOWERS in AQUATIC FACILITIES greater than 7500 square feet (697 m2) of water surface area shall be situated adjacent to each AQUATIC VENUE entry point or arranged to encourage BATHERS to use the RINSE SHOWER prior to entering the AQUATIC VENUE.

4.10.4.3.5[A] Zero Depth Entry A minimum of four showerheads per 50 feet (15.2 m) of zero depth entry AQUATIC VENUES shall be provided as a RINSE SHOWER.

4.10.4.3.6[A] Lazy River A minimum of one RINSE SHOWER shall be provided at each entrance to a LAZY RIVER AQUATIC VENUE.

4.10.4.3.7[A] Waterslide A minimum of one RINSE SHOWER shall be provided at each entrance to a WATERSLIDE queue line.

4.10.4.4[A] All Showers AQUATIC FACILITIES with 7500 square feet (697 m2) of water area or more may be flexible in the number of CLEANSING SHOWERS they provide based on the THEORETICAL PEAK OCCUPANCY in MAHC 4.1.2.3.5:

1) 25% of the required SHOWERS shall be CLEANSING SHOWERS,
2) 25% of the required SHOWERS shall be RINSE SHOWERS, and
3) the remaining 50% may be either cleansing or RINSE SHOWERS.

4.10.4.5[A] Diaper-Changing Stations

4.10.4.5.1 Each Facility All AQUATIC FACILITIES allowing use by diaper-aged BATHERS shall, upon adoption of this CODE, have at least one DIAPER-CHANGING STATION in each male and female HYGIENE FACILITY or make available a unisex DIAPER-CHANGING STATION.

4.10.4.5.1.1[A] Hand Wash Sink For existing AQUATIC FACILITIES, the adjacent plumbed handwashing sink shall be installed and operational within 1 year from the date of the AHJ's adoption of the MAHC.

4.10.4.5.1.2[A] Portable For existing AQUATIC FACILITIES that do not yet have an adjacent plumbed handwashing sink as specified in MAHC 4.10.4.5.1.1, a portable HANDWASHING STATION shall be available adjacent to the station at all times.

4.10.4.5.2[A] Conform DIAPER-CHANGING UNITS shall conform to either of the following STANDARDS:

1) ASTM Standard F2285-04: Consumer Performance Standards for Commercial Diaper-Changing Stations or
2) The STANDARDS for diaper-changing surfaces in the most current version of Caring for Our Children: National Health and Safety Performance Standards: Guidelines for Out-of-Home Child Care Programs.

4.10.4.5.3[A] Unisex If only a unisex HYGIENE FACILITY is provided, it shall have a DIAPER-CHANGING STATION that conforms to MAHC 4.10.4.5.

4.10.4.5.4[A] Trash Can A covered, hands-free, plastic-lined trash receptacle or diaper pail shall be located directly adjacent to the DIAPER-CHANGING UNIT.

4.10.4.5.5 Disinfecting Surface An EPA–REGISTERED disinfectant shall be provided for maintaining a clean and disinfected DIAPER-CHANGING UNIT surface before and after each use.

4.10.4.6 Non-Plumbing Fixture Requirements

4.10.4.6.1 Easy to Clean All HYGIENE FIXTURES and appurtenances in the dressing area shall have a smooth, hard, easy-to-clean, impervious-to-water surface and be installed to permit thorough cleaning.

4.10.4.6.2 Glass Glass, excluding mirrors, shall not be permitted in HYGIENE FACILITIES.

4.10.4.6.3 Mirrors Mirrors shall be shatter resistant.

4.10.4.6.4[A] Lockers If lockers are provided, they shall be installed at least 3.5 inches (8.9 cm) above the finished floor or on legs or a base at least 3.5 inches (8.9 cm) high and far enough apart to allow for cleaning and drying underneath the locker.

4.10.4.6.5 Soap Dispensers Soap dispensers shall be securely attached adjacent to handwashing sinks and at each CLEANSING SHOWER.

4.10.4.6.5.1 Dispenser Materials The dispensers shall be of all metal, plastic, or other shatterproof materials that can be readily and frequently cleaned.

4.10.4.6.6[A] Dryers / Paper Towels Hand dryers or paper towel dispensers shall be provided and securely attached adjacent to handwashing sinks.

4.10.4.6.6.1 Materials Hand dryers and paper towel dispensers shall be of all metal, plastic or other shatterproof materials that can be readily and frequently cleaned.

4.10.4.6.7 Toilet Paper Dispensers Toilet paper dispensers shall be securely attached to wall or partition adjacent to each toilet.

4.10.4.6.8 Female Facilities In female HYGIENE FACILITIES, covered receptacles adjacent to each toilet shall be provided for disposal of used feminine hygiene products.

4.10.4.6.9 Trash Can A minimum of one hands-free trash receptacle shall be provided in areas adjacent to handwashing sinks.

4.10.5[A] Provision of Suits, Towels, and Shared Equipment

4.10.5.1 Adequate Space AQUATIC FACILITIES supplying reusable suits, towels, and/or shared equipment shall provide adequate equipment and space for cleaning, sanitizing, drying, and storing of these materials.

4.10.6[A] Foot Baths

4.10.6.1 Prohibited FOOT BATHS shall be prohibited.

4.10.7[A] Sharps

4.10.7.1 Container If razors or other sharps are supplied by the AQUATIC FACILITY, a sharps container that complies with all applicable local, state, territorial, federal, and tribal laws shall be provided within the HYGIENE FACILITY.

4.11 Water Supply/ Wastewater Disposal

4.11.1 Water Supply

4.11.1.1[A] Public Water System Water serving an AQUATIC FACILITY shall be supplied from a potable water source.

4.11.1.1.1[A] Other Sources Other water sources such as lakes or springs may be approved to serve an AQUATIC FACILITY by the AHJ.

4.11.1.1.2[A] Condensate / Reclaimed Water Use of condensate water, collected rain water, or other reclaimed water for water serving an AQUATIC VENUE is prohibited.

4.11.1.1.2.1 Condensate Use Condensate water may be used for irrigation or other non-potable uses.

4.11.1.1.2.2 Exceptions Exceptions to MAHC 4.11.1.1.2 may be made by the AHJ with evidence that such water has met all EPA potable water quality STANDARDS.

4.11.1.2[A] Sufficient Capacity The water supply shall have sufficient capacity to simultaneously serve all PLUMBING FIXTURES.

4.11.1.2.1 Refill Pool The water supply shall have sufficient capacity and pressure to refill the AQUATIC VENUE to the operating water level after backwashing filters and after any splashing or evaporative losses within 1 hour if the AQUATIC VENUE is operational at the time of the backwash.

4.11.2[A] Fill Spout

4.11.2.1 Hazard If a fill spout is used at an AQUATIC VENUE, the fill spout shall be located so that it is not a SAFETY hazard to BATHERS.

4.11.2.2 Shielded A fill spout shall be located so the possibility of it becoming a trip hazard is minimized.

4.11.2.3 Open End The open end of fill spouts shall not have sharp edges or protrude more than 2 inches (50.8 mm) beyond the edge of the POOL.

4.11.2.4 Air Gap The discharge end shall be separated from the water by a vertical air gap of at least 2 pipe diameters measured from the pipe outlet to the edge of the POOL.

4.11.3[A] Cross-Connection Control

4.11.3.1 Protected The potable water supply serving an AQUATIC VENUE shall be protected against BACKPRESSURE consisting of either of the following:

1) An acceptable air gap consisting of a vertical distance of not less than two pipe diameters of the water supply pipe or 6 inches (15.2 cm), whichever is greater, over the lowest free-flowing discharge point of the receiving pipe, tank, or vessel. Splash guards that are open to the atmosphere may be used around the air gap, or
2) Where permitted, an approved RPZ BACKPRESSURE preventer installed according to the plumbing CODE and the AHJ.

4.11.4 Deck Drains and Rinse Showers

4.11.4.1 Sloped Walkway The walkway or DECK around an AQUATIC VENUE shall be properly sloped to DECK drains or to the edge of the DECK to prevent the accumulation of standing water.

4.11.4.2 Discharge If DECK drains are provided, the drains shall discharge to the sanitary or storm sewer or as otherwise allowed by the AHJ and according to applicable plumbing CODES.

4.11.4.3 Area or Linear DECK drains may be either area drains or linear drains. Refer to MAHC 4.8.1.3 for DECK drain area and other requirements.

4.11.4.4 Rinse Showers RINSE SHOWER drains shall discharge to the sanitary or storm sewer as allowed by the AHJ and according to applicable plumbing CODES.

4.11.5 Sanitary Wastes

4.11.5.1 Discharged Wastewater from all PLUMBING FIXTURES in the entire AQUATIC FACILITY shall be discharged to a municipal sanitary sewer system, if available.

4.11.5.2 Onsite Sewer System If a municipal sanitary sewer system is not available, all wastewater shall be disposed to an onsite sewer system that is properly designed to receive the entire wastewater capacity.

4.11.6[A] Pool Wastewater

4.11.6.1 Discharged Wastewater from an AQUATIC VENUE, including filter backwash water, shall be discharged to a sanitary sewer system having sufficient capacity to collect and treat wastewater or to an onsite sewage disposal system designed for this purpose.

4.11.6.1.1 Storm Water Systems and Surface Waters Wastewater shall not be directed to storm water systems or surface waters without appropriate permits from the AHJ or the EPA.

4.11.6.1.2 Recovery and Reuse A water recovery and reuse system may be submitted to the AHJ for review and approval.

4.11.6.2[A] Ground Surface If a municipal sanitary sewer system is not available, wastewater from an AQUATIC VENUE may be discharged to the ground surface at a suitable location as approved by the AHJ.

4.11.6.2.1 Discharged Wastewater discharged in this manner shall not cause erosion or create a threat to public health or SAFETY, a nuisance, or unlawful pollution of public waters.

4.11.6.3 Capacity The wastewater disposal system shall have sufficient capacity to receive wastewater without flooding when filters are cleaned or when the AQUATIC VENUE is drained.

4.11.6.4[A] Separation Tank for Precoat Media Filters A separation tank shall be provided prior to discharge for backwash water from precoat filters using diatomaceous earth (DE) as a filter medium.

4.11.6.4.1 Discharged For precoat filters using perlite or cellulose as a filter medium, the backwash may be discharged to the sanitary sewer, unless directed otherwise by the AHJ.

4.12 Specific Aquatic Venues

4.12.1 Spas

4.12.1.1 Additional Provisions In addition to the general AQUATIC VENUE requirements stated in this CODE, SPAS shall comply with the additional provisions or reliefs of this section.

4.12.1.2[A] Maximum Water Depth The maximum water depth in SPAS shall be 4 feet (1.2 m) measured from the designed static water line except for SPAS that are designed for SPECIAL USE and purposes and approved by the AHJ.

4.12.1.2.1 Exercise Spas The water depth for exercise SPAS shall not exceed 6 feet 6 inches (2.0 m) measured from the designed static water line.

4.12.1.2.2 Seating The maximum submerged depth of any seat or sitting bench shall be 28 inches (71.1 cm) measured from the water line.

4.12.1.3[A] Handholds A SPA shall have one or more suitable, SLIP-RESISTANT handhold(s) around the perimeter and not over 12 inches (30.5 cm) above the water line.

4.12.1.3.1 Options The handhold(s) may consist of bull-nosed coping, ledges, or DECKS along the immediate top edge of the SPA; ladders, steps, or seat ledges; or railings.

4.12.1.4 Stairs Interior steps or stairs shall be provided where SPA depths are greater than 24 inches (61.0 cm).

4.12.1.4.1 Handrail Each set of steps shall be provided with at least one handrail to serve all treads and risers.

4.12.1.4.2 Seating Seats or benches may be provided as part of these steps.

4.12.1.4.3 Approach Steps Approach steps on the exterior of a SPA wall extending above the DECK shall also be required unless the raised SPA wall is 19 inches (48.3 cm) or less in height above the DECK and it is used as a transfer tier or pivot-seated entry.

4.12.1.5[A] Perimeter Deck A 4 foot (1.2 m) wide, continuous, unobstructed PERIMETER DECK shall be provided on two consecutive or adjacent sides or fifty percent or more of the SPA perimeter.

4.12.1.5.1 Lower Ratio The AHJ could consider a lower ratio upon review of an appropriate SAFETY PLAN that addresses adequate access.

4.12.1.5.2 Coping The PERIMETER DECK may include the coping.

4.12.1.5.3 Recessed SPAS may be located adjacent to other AQUATIC VENUES as long as they are recessed in the DECK.

4.12.1.5.4[A] Elevated Spas Elevated SPAS may be located adjacent to another AQUATIC VENUE as long as there is an effective BARRIER between the SPA and the adjacent AQUATIC VENUE.

4.12.1.5.5 Minimum Distance If an effective BARRIER is not provided, a minimum distance of 4 feet (1.2 m) between the AQUATIC VENUE and SPA is required.

4.12.1.6 Depth Markers A minimum of two depth markers shall be provided regardless of the shape or size of the SPA.

4.12.1.7[A] Temperature Water temperatures shall not exceed 104°F (40°C).

4.12.1.8 Drain A means to drain the SPA shall be provided to allow frequent draining and cleaning.

4.12.1.9 Air Induction System An air induction system, when provided, shall prevent water back up that could cause electrical shock hazards.

4.12.1.9.1 Intake Air intake sources shall not permit the introduction of toxic fumes or other CONTAMINANTS.

4.12.1.10[A] Timers The hydrotherapy jet system shall be connected to a minute timer that does not exceed 15 minutes to limit the period of agitation.

4.12.1.10.1 Out of Bather Reach The hydrotherapy jet system shall be connected to a minute timer located out of reach of a BATHER in the SPA.

4.12.1.11[A] Emergency Shutoff All SPAS shall have a clearly labeled emergency shutoff or control switch for the purpose of stopping the motor(s) that provide power to the RECIRCULATION SYSTEM and hydrotherapy or hydrotherapy jet system.

4.12.1.11.1 Readily Accessible All SPAS shall have a clearly labeled emergency shutoff or control switch that shall be installed and be readily accessible to the BATHERS, in accordance with the NEC.

4.12.1.11.2 Not Less Than Emergency Shut Off or control switches shall be located:

1) Within sight of the SPA, and
2) Not less than 5 feet (1524 mm) or greater than 10 feet (3048 mm) horizontally from the inside walls of the SPA.

4.12.1.11.3 Alarms Alarms for SPAS shall:

1) Have an audible warning with a rating of not less than 80 decibels, and
2) Have a flashing light, and
3) Be designed to continuously until deactivated with the shut off switch

4.12.1.11.4 Signage Signage shall be posted according to 4.12.1.11.2 and 6.4.2.2.2 advising BATHERS not to use the Spa when alarm is activated.

4.12.1.12 Clock SPAS shall have a clock that is visible to all BATHERS.

4.12.2 Waterslides and Landing Pools

4.12.2.1[A] Design and Construction

4.12.2.1.1 Additional Provisions In addition to the general AQUATIC FACILITY requirements stated in this CODE, WATERSLIDES and LANDING POOLS shall comply with the additional provisions or reliefs of this section.

4.12.2.1.2 Recognized Standards The following recognized design and construction STANDARDS for WATERSLIDES shall be adhered to.

4.12.2.1.2.1 Engineer Compliance The DESIGN PROFESSIONAL shall provide documentation and/or certification that the WATERSLIDE design is in conformance with these STANDARDS:

1) ASTM F2376-17a Standard Practice for Classification, Design, Manufacture, Construction, and Operation of Water Slide Systems and
2) ASTM F2461-16e1. Standard Practice for Manufacturer, Construction, Operation, and Maintenance of Aquatic Play Equipment.

4.12.2.1.2.2 Required Signage Signs indicating riding instructions, warnings, and requirements in accordance with the manufacturer recommendations shall be posted at the WATERSLIDE entry.

4.12.2.2 Flumes

4.12.2.2.1 Surfaces FLUME surfaces shall be inert, nontoxic, smooth, and easily cleaned.

4.12.2.2.2 Dips All FLUME VALLEYS and DIPS shall have proper drainage, SAFETY measures that ensure a rider cannot fall from the FLUME, and a means of egress in the event the ride malfunctions or a rider stops on the ride.

4.12.2.2.3 Landing Pool The exit of any FLUME shall be designed to ensure that BATHERS enter the LANDING POOL or SLIDE RUNOUT at a safe speed and angle of entry.

4.12.2.2.4 Intersection If a WATERSLIDE has two or more FLUMES and there is a point of intersection between the centerlines of any two FLUMES, the distance between that point and the point of exit for each intersecting FLUME shall not be less than the SLIDE manufacturer's recommendations and ASTM F2376.

4.12.2.3[A] Exit into Landing Pools

4.12.2.3.1 Water Level WATERSLIDES shall be designed to terminate at or below water level, except for DROP SLIDES or unless otherwise permitted by the WATERSLIDE manufacturer and ASTM F2376.

4.12.2.3.2 Perpendicular WATERSLIDES shall be perpendicular to the wall of the AQUATIC VENUE at the point of exit unless otherwise permitted by the WATERSLIDE manufacturer.

4.12.2.3.3 Exit System WATERSLIDES shall be designed with an exit system which shall be in accordance with the WATERSLIDE manufacturer's recommendations and ASTM F2376.

4.12.2.3.3.1 Safe Entry WATERSLIDES shall be designed with an exit system which shall provide safe entry into the LANDING POOL or WATERSLIDE RUNOUT.

4.12.2.3.4 Flume Exits The FLUME exits shall be in accordance with the WATERSLIDE manufacturer's recommendations and ASTM F2376.

4.12.2.3.5 Point of Exit `The distance between the point of exit and the side of the AQUATIC VENUE opposite the BATHERS as they exit, excluding any steps, shall not be less than the WATERSLIDE manufacturer's recommendations and in accordance with ASTM F2376.

4.12.2.4 Landing Pools

4.12.2.4.1 Steps If steps are provided instead of exit ladders or RECESSED STEPS with grab rails, they shall be installed at the opposite end of the LANDING POOL from the FLUME exit with a handrail.

4.12.2.4.2 Landing Area If the WATERSLIDE FLUME ends in a swimming POOL, the landing area shall be divided from the rest of the AQUATIC VENUE by a ROPE AND FLOAT LINE, WING WALL, PENINSULA, or other similar feature to prevent collisions with other BATHERS.

4.12.2.5 Decks A PERIMETER DECK shall be provided along the exit side of the LANDING POOL.

4.12.2.6 Means of Access A walkway, steps, stairway, or ramp shall be provided between the LANDING POOL and the top of the FLUME. Refer to MAHC 4.8.1 for more guidance on DECK spaces.

4.12.2.7 Slide Runouts

4.12.2.7.1 Egress WATERSLIDE RUNOUTS, if used, shall have a planned means of egress, unless one of the walls of the RUNOUT is not more than 19 inches (48.3 cm) in height.

4.12.2.7.2 Designed WATERSLIDE RUNOUTS shall be designed in accordance with the SLIDE manufacturer's recommendations and ASTM F2376.

4.12.2.8[A] Drop Slides

4.12.2.8.1 Landing Area There shall be a SLIDE landing area in accordance with the SLIDE manufacturer's recommendations and ASTM F2376.

4.12.2.8.2 Area Clearance This area shall not infringe on the landing area for any other SLIDES, diving equipment, or any other minimum AQUATIC VENUE clearance requirements.

4.12.2.8.3 Steps Steps shall not infringe on this area.

4.12.2.8.4 Water Depth The minimum required water depth shall be a function of the vertical distance between the terminus of the SLIDE surface and the water surface of the LANDING POOL.

4.12.2.8.5 Manufacturer's Recommendation The minimum required water depth shall be in accordance with the SLIDE manufacturer's recommendations and ASTM F2376.

4.12.2.9 Pool Slides

4.12.2.9.1 Designed for Safety All SLIDES installed as an appurtenance to an AQUATIC VENUE shall be designed, constructed, and installed to provide a safe environment for all BATHERS utilizing the AQUATIC VENUE in accordance with applicable ASTM STANDARDS. Portable slides are prohibited.

4.12.2.9.2 Non-Toxic Components used to construct a POOL SLIDE shall be non-toxic and compatible with the environment contacted under normal use.

4.12.2.9.3 Water Depth Water depth at the SLIDE terminus shall be determined by the SLIDE manufacturer.

4.12.2.9.4 Pool Edge Clear space shall be maintained to the POOL edge and other features per manufacturer requirements.

4.12.2.9.4.1 Landing Area The landing area of the SLIDE shall be protected through the use of a ROPE AND FLOAT LINE, WING WALL, PENINSULA, or other similar impediment to prevent collisions with other BATHERS.

4.12.2.9.4.2 Prevent Bather Access Netting or other BARRIERS shall be provided to prevent BATHER access underneath POOL SLIDES where sufficient clearance is not provided.

4.12.2.9.4.3 Netting or Barrier Such netting or other BARRIER shall be designed such that any underwater opening does not allow for the passage of a 4 inch (10.2 cm) ball and no opening can create a finger entrapment.

4.12.2.10 Signage Warning signs in accordance with manufacturer's recommendations shall be provided.

4.12.3[A] Wave Pools

4.12.3.1 General

4.12.3.1.1 Additional Provisions In addition to the general swimming POOL requirements stated in this CODE, WAVE POOLS shall comply with the additional provisions or reliefs of this section.

4.12.3.2 Access

4.12.3.2.1 Access Point BATHERS shall gain access to the WAVE POOL at the shallow or zero depth entry with the exception of an allowable ADA designated entry point.

4.12.3.2.1.1 Sides The sides of the WAVE POOL shall be protected from unauthorized entry into the WAVE POOL by the use of a BARRIER.

4.12.3.2.1.2 Handrails Handrails as required by ADA for accessible entries shall be designed in such a way that they do not present a potential for injury or entrapment with WAVE POOL BATHERS.

4.12.3.2.2 Perimeter Decks A PERIMETER DECK shall not be required around 100% of the WAVE POOL perimeter.

4.12.3.2.2.1 Wave Pool Access A PERIMETER DECK shall be provided where BATHERS gain access to the WAVE POOL at the shallow or zero depth entry and in locations where access is required for lifeguards.

4.12.3.2.3 Handholds WAVE POOLS shall be provided with handholds at the static water level or not more than 6 inches (15.2 cm) above the static water level.

4.12.3.2.3.1 Continuous These handholds shall be continuous around the WAVE POOL'S perimeter with the exception of at the ZERO DEPTH ENTRY, water depths less than 24 inches (61.0 cm), if this area is roped off not allowed for BATHER access.

4.12.3.2.3.2 Self Draining These handholds shall be self-draining.

4.12.3.2.3.3 Flush Handholds shall be installed so that their outer edge is flush with the WAVE POOL wall.

4.12.3.2.3.4 Entangled The design of the handholds shall ensure that body extremities will not become entangled during wave action.

4.12.3.2.4 Steps and Handrails RECESSED STEPS shall not be allowed along the walls of the WAVE POOL due to the entrapment potential.

4.12.3.2.5 Ladders Side wall ladders shall be utilized for egress only.

4.12.3.2.5.1 Placement Side wall ladders shall be placed so they do not project beyond the plane of the wall surface.

4.12.3.2.6 Rope and Float Line WAVE POOLS shall be fitted with a ROPE AND FLOAT LINE located to restrict access to the caisson wall if required by the WAVE POOL equipment manufacturer.

4.12.3.2.6.1 Exception ROPE AND FLOAT LINE shall not apply to WAVE POOLS as indicated in provisions of MAHC 4.5.19.5.3.

4.12.3.3 Safety

4.12.3.3.1 Life Jackets Proper STORAGE shall be provided for life jackets and all other equipment used in the WAVE POOL that will allow for thorough drying to prevent mold and other biological growth.

4.12.3.3.2 Shut-Off Switch A minimum of two emergency shutoff switches to disable the wave action shall be provided, one on each side of the WAVE POOL.

4.12.3.3.2.1 Labeled and Accessible These switches shall be clearly labeled and readily accessible to QUALIFIED LIFEGUARDS.

4.12.3.3.3 Caisson Enclosure Caisson ENCLOSURES that prevent the passage of a 4-inch (10.2 cm) ball shall be provided for all WAVE POOLS.

4.12.4 Therapy Pools

4.12.4.1 Additional Provisions In addition to the general AQUATIC VENUE requirements stated in this CODE, THERAPY POOLS shall comply with the additional provisions or reliefs of this section and MAHC 4.7.3.3 on SECONDARY TREATMENT.

4.12.4.2 Slope Floor slope may exceed 1 foot (30.5 cm) in 12 feet (3.7 m) for water shallower than 5 feet (1.5 m).

4.12.4.2.1 Break Points Break points in floor slope shall be identified with a contrasting band consistent with MAHC 4.5.4.2.

4.12.4.3 Hydrotherapy Hydrotherapy jet systems shall be independent of the recirculation, filtration, and heating systems.

4.12.4.4 Special Equipment Special equipment may be allowed by the AHJ with proper justification.

4.12.5 Lazy Rivers

4.12.5.1 General

4.12.5.1.1 Additional Provisions In addition to the general swimming AQUATIC VENUE requirements stated in this CODE, LAZY RIVERS shall comply with the additional provisions or reliefs of this section.

4.12.5.1.2 Protrusions Handrails, steps, stairs, and propulsion jets for LAZY RIVERS shall not protrude into the river.

4.12.5.2 Access and Egress

4.12.5.2.1[A] Means Means of access/egress shall be provided at 150 foot (45.7 m) intervals around the LAZY RIVER.

4.12.5.2.2[A] Handhold A handhold in compliance with MAHC 4.5.14 shall be required on at least one side of the LAZY RIVER but shall not include horizontal bars and/or recessed handholds.

4.12.5.2.2.1 Bathers In or On Tubes Exception: Handholds shall not be required where BATHERS are required to be in or on a tube while in the LAZY RIVER.

4.12.5.2.3[A] Deck A DECK shall be provided along the entire length of the LAZY RIVER.

4.12.5.2.3.1 Alternate Sides The DECK shall be allowed to alternate sides of the LAZY RIVER.

4.12.5.2.3.2 Obstructions Obstructions around the perimeter of the LAZY RIVER, such as bridges or landscaping, shall be allowed provided they do not impact lifeguarding, sight lines, or rescue operations.

4.12.5.2.4[A] Bridges All bridges spanning a LAZY RIVER shall have a minimum clearance of both 7 feet (2.1 m) from the bottom of the LAZY RIVER and 4 feet (1.2 m) above the water surface to any structure overhead.

4.12.6 Moveable Floors

4.12.6.1 General

4.12.6.1.1 Additional Provisions In addition to the general swimming AQUATIC VENUE requirements stated in this CODE, MOVEABLE FLOORS shall comply with the additional provisions or reliefs of this section.

4.12.6.1.2 Water Treatment The MOVEABLE FLOOR design shall not impede the effectiveness of the water treatment system.

4.12.6.1.3 Underneath MOVEABLE FLOORS shall allow inspection, cleaning, and maintenance of the area underneath.

4.12.6.2 Slip Resistant The surface of the MOVEABLE FLOOR shall be SLIP RESISTANT if it is intended for installation in water depths less than 5 feet (1.5 m).

4.12.6.3 Safety

4.12.6.3.1[A] Not Continuous A strategy for preventing BATHERS from transitioning to deeper water when a MOVEABLE FLOOR is not continuous over the entire surface area of the AQUATIC VENUE shall be provided.

4.12.6.3.2[A] Underside The underside of the MOVEABLE FLOOR shall not be accessible to BATHERS.

4.12.6.3.3 Entrapment The design of a MOVEABLE FLOOR shall protect against BATHER entrapment between the MOVEABLE FLOOR and the POOL walls and floor.

4.12.6.3.4 Hydraulic Fluid If the MOVEABLE FLOOR is operated using hydraulics, the hydraulic compounds shall be listed as safe for use in POOL water in case there is a hydraulic leak.

4.12.6.4[A] Movement

4.12.6.4.1 Speed The speed of a MOVEABLE FLOOR shall be less than or equal to 1.5 feet per minute (45.7 cm/min).

4.12.6.4.2 Use Use of the MOVEABLE FLOOR portion of the POOL shall not be open to BATHERS when the floor is being raised or lowered.

4.12.6.4.2.1 Accessibility Exception: The MOVEABLE FLOOR shall only be used for accessibility purposes under direct supervision.

4.12.6.5 Water Depth and Markings

4.12.6.5.1 Displayed A floor depth indicator shall be provided that displays the current POOL water depth.

4.12.6.5.2 Warning Markings Warning markings stating “Moveable Floor” shall be provided at 25 foot (7.6 m) intervals around the perimeter of the MOVEABLE FLOOR.

4.12.7 Bulkheads

4.12.7.1 Additional Provisions In addition to the general AQUATIC VENUE requirements stated in this CODE, BULKHEADS shall comply with the additional provisions or reliefs of this section.

4.12.7.2[A] Entrapment The bottom of the BULKHEAD shall be designed so that a BATHER cannot be entrapped underneath or inside of the BULKHEAD.

4.12.7.3 Placement The BULKHEAD placement shall not interfere with the required water circulation in the POOL.

4.12.7.4 Fixed BULKHEADS shall be fixed to their operational position(s) by a tamper-proof system.

4.12.7.5[A] Gap The gap between the BULKHEAD and the POOL wall shall be no greater than 1.5 inches (3.8 cm).

4.12.7.6[A] Handhold The BULKHEAD shall be designed to afford an acceptable handhold as required in MAHC 4.5.14.

4.12.7.7 Entrances and Exits The proper number of entrances/exits to the POOL as required by MAHC 4.5.3 shall be provided when the BULKHEAD is in place.

4.12.7.8 Guard Railings Guard railings at least 34 inches (86.4 cm) tall shall be provided on both ends of the BULKHEAD.

4.12.7.9[A] Width The width of the walkable area (total BULKHEAD width) of a BULKHEAD shall be greater than or equal to 3 feet and 3 inches (1.0 m).

4.12.7.9.1[A] Starting Platforms If starting platforms are installed, the width of the walkable area (total BULKHEAD width) of a BULKHEAD shall be greater than or equal to 3 feet and 9 inches (1.1 m).

4.12.7.9.1.1 Side Mount Style Starting platforms shall be "side mount" style if BULKHEAD is less than 4 feet 6 inches (1.4 m) wide.

4.12.7.10 Bulkhead Travel The travel of a BULKHEAD shall be in accordance with one of the following:

1) Limited such that it cannot encroach on any required clearances of other features, such as diving boards, or
2) Designed with modifications incorporated that prevent use of other features when the required clearances have been compromised by the position of the BULKHEAD.

4.12.7.11 Bulkhead Installation BULKHEADS shall not be installed, unless designed, and operated in accordance with all manufacturer's installation and operations recommendations.

4.12.7.12 Open Area If a BULKHEAD is operated with an open area underneath, safety signage shall be provided on the bulkhead, in letters at least 4 inches (102 mm) high, which states "DANGER! DO NOT SWIM UNDER BULKHEAD."

4.12.8[A] Interactive Water Play Venues

4.12.8.1 Additional Provisions In addition to the general AQUATIC VENUE requirements stated in this CODE, INTERACTIVE WATER PLAY VENUES shall comply with the additional provisions or reliefs of this section.

4.12.8.2 Surface INTERACTIVE WATER PLAY VENUES shall have a SLIP-RESISTANT and easily cleaned surface.

4.12.8.2.1 Manufactured Surfacing Any manufactured surfacing shall be deemed suitable by the manufacturer for aquatic and chlorinated environments.

4.12.8.3[A] Sloped The INTERACTIVE WATER PLAY VENUE shall be properly sloped so that only water from the AQUATIC FEATURES flows back to the INTERACTIVE WATER PLAY VENUE collection tank for recirculated venues, or to drainage for proper wastewater disposal for NON-RECIRCULATED venues.

4.12.8.3.1 Adjacent Areas Areas adjacent to the INTERACTIVE WATER PLAY VENUE shall be sloped away from the collection drains.

4.12.8.3.2 Water Collection The slope of the INTERACTIVE WATER PLAY VENUE shall be sufficient to prevent standing water from collecting on the pad.

4.12.8.4 Drains The size, number and locations of the INTERACTIVE WATER PLAY VENUE drains shall be determined and specified so as to assure water does not accumulate on the INTERACTIVE WATER PLAY VENUES.

4.12.8.4.1 Gravity Flow through the drains to the INTERACTIVE WATER PLAY VENUE collection tank for recirculated venues, or wastewater disposal for NON-RECIRCULATED venues, shall be under gravity.

4.12.8.4.2 Direct Suction Outlets Direct suction outlets from the INTERACTIVE WATER PLAY VENUE shall be prohibited.

4.12.8.4.3 Valving Valves shall be provided in the drain system to allow for discharging water to an approved means for wastewater disposal prior to returning to the collection tank when INTERACTIVE WATER PLAY AQUATIC VENUE is not operational.

4.12.8.4.3.1 Valves Before Valves shall be located before returning to the collection tank when the INTERACTIVE WATER PLAY AQUATIC VENUE is not operational so that wastewater from the venue is diverted for proper disposal for stormwater as required by the AHJ.

4.12.8.5 Grate Openings Openings in the grates covering the drains shall not exceed ½ inches (12.7 mm) wide.

4.12.8.5.1 Tools Gratings shall not be removable without the use of tools.

4.12.8.6 Treatment Tank For recirculated venues, the INTERACTIVE WATER PLAY VENUE collection tank shall be designed to provide ready access for cleaning and inspections.

4.12.8.6.1 Completely Drain The INTERACTIVE WATER PLAY VENUE collection tank shall be capable of complete draining.

4.12.8.6.2 Access Hatch The access hatch or lid shall be locked or require a tool to open.

4.12.8.6.3 Capacity The collection tank shall have a minimum operational volume of 3,000 gallons (11,356 L) of water.

4.12.8.6.3.1 Volume The volume of water in the collection tank shall be sufficient to assure continuous operation of the filtration system.

4.12.8.6.4 Overflow Pipe A means to convey excess water in the tank to an AHJ approved waste disposal system shall be provided.

4.12.8.6.5[A] Inlets RECIRCULATION SYSTEM INLETS shall be sized and positioned to provide for complete mixing in the tank.

4.12.8.7 Deck Area INTERACTIVE WATER PLAY VENUES shall be kept free of landscape debris by either:

1) Eight feet (2.4 m) of DECK area,
2) Raised curbs, or
3) Raised planters.

4.12.8.7.1 Deck Surface The DECK shall be of a uniform, easily cleaned, impervious material.

4.12.8.7.2 Protected From Runoff The DECK shall be protected from surface runoff.

4.12.8.8 Barrier A BARRIER shall be provided to separate an INTERACTIVE WATER PLAY VENUE from another BODY OF WATER within the same facility.

4.12.8.8.1 Exception: Separated by Distance Exception: The INTERACTIVE WATER PLAY VENUE is separated by a distance of at least 15 feet (4.6 m) from other bodies of water.

4.12.8.9 Enclosures If a facility only consists of an INTERACTIVE WATER PLAY VENUE, then the requirements for an ENCLOSURE shall not apply.

4.12.8.10[A] Hazard Spray features shall be designed and installed to be seen clearly, so as not to be a hazard to BATHERS due to water velocity from the spray feature discharge, or other SAFETY hazards.

4.12.8.10.1 Surface Sprays Surface sprays shall be flush with the spray pad surface. Spray openings shall have a diameter of ½ inch (0.127 mm) or less. Noncircular spray openings shall have a width of ½ inch (0.127 m) or less.

4.12.8.10.2 Aboveground Features Aboveground features shall not present a tripping hazard. Features shall have no sharp edges, rough surfaces, pinch points, crush and shearing points, entanglement and impalement hazards, or entrapment hazards. The features shall not be climbable unless there is a safety pad coving the spray pad surface in fall zone that complies with ASTM F1292 for fall protection. Above

ground features shall be constructed of corrosion-resistant materials or provided with a corrosion-resistant coating. Accessible spray openings shall have a diameter of ½ inch (0.127 mm) or less. Noncircular accessible spray openings shall have a width of ½ inch (0.127 mm) or less.

4.12.8.11 Maximum Velocity Maximum velocity at the orifice of the spray feature nozzle shall not exceed 20 feet (6.1 m) per second.

4.12.8.12[A] Signage Depth markings and warning signs shall not be required for INTERACTIVE WATER PLAY VENUES.

4.12.8.13 NEC Requirements NEC swimming POOL requirements shall apply to INTERACTIVE WATER PLAY VENUES.

4.12.8.14 Regular Draining and Flushing Plumbing design including spray features, spray features piping, and spray features reservoirs shall be designed so that water can be completely drained out when the venue is not in operation and the entire plumbing system can be flushed prior to each operation.

4.12.9 Wading Pools

4.12.9.1 Additional Provisions In addition to the general AQUATIC VENUE requirements stated in this CODE, WADING POOLS shall comply with the additional provisions or reliefs of this section.

4.12.9.2[A] Barrier A BARRIER shall be provided to separate a WADING POOL from other POOLS unless the WADING POOL is separated by a distance of 15 feet (4.6 m) from other BODIES OF WATER.

4.12.9.2.1 Complete Barrier The BARRIER shall not be required to completely surround the WADING POOL if the shortest distance of travel between the WADING POOL around the BARRIER to the other POOL is a minimum of 15 feet (4.67 m).

4.12.9.2.2[A] Shallow Water WADING POOLS near other WADING POOLS shall not be required to be separated by a BARRIER.

4.12.10[A] Other Aquatic Features Other AQUATIC FEATURES not otherwise addressed in the CODE, including but not limited to climbing walls, inflatables, and play structures, shall not be installed unless designed and operated in accordance with all manufacturer's installation and operations recommendations.

5.0 Aquatic Facility Operation and Maintenance

The provisions of Chapter 5 apply to all AQUATIC FACILITIES covered by this CODE regardless of when constructed, unless otherwise noted.

Note: Section numbers with superscript "A" (e.g., 5.0[A]) denote a corresponding discussion in the Annex to the Model Aquatic Health Code.

5.1 Operating Permits

5.1.1 Owner Responsibilities

5.1.1.1 Operating Permit Required The AQUATIC FACILITY owner shall apply to the AHJ for an operating permit and the operating permit must be issued prior to opening to the public.

5.1.1.2 Separate A separate operating permit is required for each AQUATIC VENUE if there are multiple AQUATIC VENUES within the same aquatic facility, and newly constructed or SUBSTANTIALLY ALTERED AQUATIC VENUE at an existing AQUATIC FACILITY.

5.1.1.3 Prior to Issuance Before an operating permit is issued, the following procedures shall be completed:

1) The AQUATIC FACILITY owner has demonstrated the AQUATIC FACILITY, including all newly constructed or SUBSTANTIALLY ALTERED AQUATIC VENUES, is in compliance with the requirements of this CODE, and
2) The AHJ has approved the AQUATIC FACILITY to be open to the public.

5.1.1.4 Details The operating permit shall:

1) Be issued in the name of the owner,
2) List all AQUATIC VENUES included under the operating permit, and
3) Specify the period of time approved by the AHJ.

5.1.1.5 Expiration Operating permits shall terminate according to the AHJ schedule.

5.1.1.6 Renewal The AQUATIC FACILITY owner shall renew the permit to operate prior to the scheduled expiration of an existing permit to operate an AQUATIC FACILITY.

5.1.1.7 Denial The operating permit may be denied or withheld, suspended or revoked, by the AHJ for noncompliance of the AQUATIC FACILITY with the requirements of this CODE.

5.1.1.8 Owner Responsibilities The owner of an AQUATIC FACILITY is responsible for the facility being operated, maintained, and managed in accordance with the requirements of this CODE.

5.1.2 Operating Permits

5.1.2.1 Location The operating permit shall be posted at the AQUATIC FACILITY in a location conspicuous to the public.

5.1.2.2 Operating Without an Operating Permit Operation of an AQUATIC FACILITY or newly constructed or SUBSTANTIALLY ALTERED AQUATIC VENUE without an operating permit shall be prohibited.

5.1.2.3 Required Closure The AHJ may order a newly constructed or SUBSTANTIALLY ALTERED AQUATIC VENUE without an operating permit to close until the AQUATIC FACILITY has obtained an operating permit.

5.2 Inspections

5.2.1 Preoperational Inspections

5.2.1.1 Terms of Operation The AQUATIC FACILITY may not be placed in operation until an inspection approved by the AHJ shows compliance with the requirements of this CODE or the AHJ approves opening for operation.

5.2.2 Exemptions

5.2.2.1 Applying for Exemption An AQUATIC FACILITY seeking an initial exemption or an existing AQUATIC FACILITY claiming to be exempt according to applicable regulations shall contact the AHJ for application details/forms.

5.2.2.2 Change in Exemption Status An AQUATIC FACILITY that sought and received an exemption from a public regulation shall contact the AHJ if the conditions upon which the exemption was granted change so as to eliminate the exemption status.

5.2.3[A] Variances

5.2.3.1 Variance Authority The AHJ may grant a variance to the requirements of this CODE.

5.2.3.2 Applying for a Variance An AQUATIC FACILITY seeking a variance shall apply in writing with the appropriate forms to the AHJ.

5.2.3.2.1 Application Components The application shall include, but not be limited to:

1) A citation of the CODE section to which the variance is requested,
2) A statement as to why the applicant is unable to comply with the CODE section to which the variance is requested,
3) The nature and duration of the variance requested,
4) A statement of how the intent of the CODE will be met and the reasons why the public health or SAFETY would not be jeopardized if the variance was granted, and
5) A full description of any policies, procedures, or equipment that the applicant proposes to use to rectify any potential increase in health or SAFETY risks created by granting the variance.

5.2.3.3 Revoked Each variance shall be revoked when the operating permit attached to it is revoked.

5.2.3.4 Not Transferable A variance shall not be transferable unless otherwise provided in writing at the time the variance is granted.

5.3 Equipment Standards [N/A]

5.4 Aquatic Facility and Venue Operation and Maintenance

5.4.1 Closure and Reopening

5.4.1.1[A] Closure If an AQUATIC VENUE is not open to the public, the following conditions shall be met to protect health and SAFETY:

5.4.1.1.1 Aquatic Venues With an Enclosure Where the AQUATIC VENUE has an ENCLOSURE enclosing it per MAHC 4.8.6:

1) The water shall be recirculated and treated to meet the criteria of this CODE;
2) The water shall be drained;
3) An approved safety cover that is CERTIFIED, LISTED, AND LABELED to ASTM F1346-91 by an ANSI-accredited certification organization shall be installed; or

4) Where a safety cover is not used or not practical, access to the AQUATIC VENUE shall be restricted and routine checks of the integrity of the AQUATIC VENUE ENCLOSURE shall be made.

5.4.1.1.2 Aquatic Venues Without an Enclosure but Open to the Public Where the AQUATIC VENUE does not have an ENCLOSURE enclosing it per MAHC 4.8.6 and other parts of the AQUATIC FACILITY are open to the public:

1) The water shall be recirculated and treated to meet the criteria of this CODE and the AQUATIC VENUE shall be staffed to keep BATHERS out;
2) The water shall be drained, and the AQUATIC VENUE shall be staffed to keep BATHERS out;
3) A temporary BARRIER for the AQUATIC VENUE shall be installed to keep BATHERS out, and routine checks of the integrity of the temporary AQUATIC VENUE BARRIER shall be made; or
4) An approved safety cover that is CERTIFIED, LISTED, AND LABELED to ASTM F1346-91 by an ANSI-accredited certification organization shall be installed.

5.4.1.1.3 Aquatic Venues Without an Enclosure and Closed to the Public Where the aquatic venue does not have an enclosure enclosing it per MAHC 4.8.6, and the aquatic facility is closed to the public:

1) The water shall be recirculated and treated to meet the criteria of this CODE;
2) The water shall be drained;
3) An approved safety cover CERTIFIED, LISTED, AND LABELED to ASTM F1346-91 by an ANSI-accredited certification organization shall be installed; or
4) Where a safety cover is not used or not practical, access to the AQUATIC FACILITY shall be restricted and routine checks of the integrity of the AQUATIC FACILITY ENCLOSURE shall be made.

5.4.1.2[A] Reopening An owner or operator of a closed AQUATIC VENUE shall verify that the AQUATIC VENUE meets all applicable criteria of this CODE before reopening the AQUATIC VENUE.

5.4.2[A] Preventive Maintenance Plan

5.4.2.1 Written Plan

5.4.2.1.1 Preventive Maintenance Plan Available A written comprehensive preventive maintenance plan for each AQUATIC VENUE shall be available at the AQUATIC FACILITY.

5.4.2.1.2 Contents The AQUATIC FACILITY preventive maintenance plan shall include details and frequency of owner/operator's planned routine facility inspection, maintenance, and replacement of recirculation and water treatment components.

5.4.2.2[A] Facility Documentation

5.4.2.2.1 Original Plans and Specifications Available A copy of the approved plans and specifications for each AQUATIC VENUE constructed after the adoption of this CODE shall be available at the AQUATIC FACILITY.

5.4.2.2.2 Equipment Inventory A comprehensive inventory of all mechanical equipment associated with each AQUATIC VENUE shall be available at the AQUATIC FACILITY.

5.4.2.2.3 Inventory Details This inventory shall include:

1) Equipment name and model number;
2) Manufacturer and contact information;
3) Local vendor/supplier and technical representative, if applicable; and

4) Replacement or service dates and details.

5.4.2.2.4 Equipment Manuals Operation manuals for all mechanical equipment associated with each AQUATIC VENUE shall be available at the AQUATIC FACILITY.

5.4.2.2.4.1 No Manual If no manufacturer's operation manual is available, then the AQUATIC FACILITY shall create a written document that outlines STANDARD operating procedures for maintaining and operating the piece of equipment.

5.4.3 General Operations [N/A]

5.4.3.1 Theoretical Peak Occupancy The THEORETICAL PEAK OCCUPANCY per MAHC 4.1.2.3.5 shall not be exceeded.

5.5 Aquatic Venue Structure

5.5.1 Shape [N/A]

5.5.2 Access Ladders

5.5.2.1 Securely Anchored Ladders, grab rails, and handrails shall be securely anchored.

5.5.3 Color and Finish [N/A]

5.5.4 Walls [N/A]

5.5.5[A] Depth Markings

5.5.5.1 Depth Markers Depth markers shall be provided in locations in accordance with MAHC 4.5.19 and maintained.

5.5.5.2 No Diving Markers NO DIVING MARKERS shall be provided in accordance with MAHC 4.5.19 and maintained.

5.5.5.3 Ropes and Float Lines ROPES AND FLOAT LINES shall be installed as required in MAHC 4.5.19.5.3, 4.12.2.5.2, 4.12.2.10.4.1, and 4.12.3.2.6.

5.5.6[A] Pool Shell Maintenance

5.5.6.1 Cracking

5.5.6.1.1 Repaired CRACKS shall be part of the daily inspection process and be repaired when they change sufficiently to increase the potential for:

1) Leakage,
2) Trips or falls,
3) Lacerations, or
4) Impact the ability to properly clean and maintain the AQUATIC VENUE area.

5.5.6.1.2 Document Cracks Surface CRACKS under 1/8 inch (3.2 mm) wide shall be documented and MONITORED for any movement or change including opening, closing, and/or lengthening.

5.5.6.1.3 Sharp Edges Any sharp edges shall be removed or repaired.

5.6 Indoor / Outdoor Environment

5.6.1 Lighting

5.6.1.1 Lighting Maintained

5.6.1.1.1[A] Light Levels Lighting systems, including emergency lighting, shall be maintained in all PATRON areas and maintenance areas, to ensure the required lighting levels are met as specified in MAHC 4.6.1.

5.6.1.1.2[A] Main Drain Visible The AQUATIC VENUE shall not be open if light levels are such that the main drain is not visible from poolside.

5.6.1.1.2.1 With an Enclosure The AQUATIC FACILITY may remain open for other events if the closed AQUATIC VENUE has an ENCLOSURE.

5.6.1.1.3[A] Underwater Lighting Underwater lights, where provided, shall be operational and maintained as designed.

5.6.1.1.3.1 Ground-Fault Circuit Interrupter Branch circuits that supply underwater lights operating at more than the Low Voltage Contact Limit as defined in NEC 680.2 shall be GFCI protected.

5.6.1.1.3.2 Unprotected Light Circuit Operation of an unprotected underwater light circuit shall be prohibited.

5.6.1.1.4 Cracked Lenses CRACKED lenses that are physically intact on lights shall be replaced before the AQUATIC VENUE reopens to BATHERS.

5.6.1.1.5 Intact Lenses The AQUATIC VENUE shall be immediately closed if CRACKED lenses are not intact and the lenses shall be replaced before reopening.

5.6.1.2[A] Glare

5.6.1.2.1[A] Assessments The AQUATIC FACILITY owner shall ensure that glare conditions are assessed to determine if the AQUATIC VENUE bottom and objects in the POOL are clearly visible throughout operating hours.

5.6.1.2.1.1[A] Lifeguard Positions If the AQUATIC VENUE requires lifeguards, the AQUATIC FACILITY owner shall ensure that glare conditions are assessed from each lifeguard position as identified in the zone of PATRON surveillance to determine if the AQUATIC VENUE bottom and objects in the POOL are clearly visible to QUALIFIED LIFEGUARD staff throughout operating hours per MAHC 6.3.3.1.1.

5.6.1.2.2 Reduction Windows and lighting equipment shall be adjusted, if possible, to minimize glare and excessive reflection on the water surface.

5.6.1.3 Night Swimming Night swimming shall be prohibited unless required light levels in accordance with MAHC 4.6.1 are provided.

5.6.1.3.1 Hours Night swimming shall be considered one half hour before sunset to one half hour after sunrise.

5.6.1.4 Emergency Lighting Emergency lighting shall be tested and maintained according to manufacturer's recommendations.

5.6.2[A] Indoor Aquatic Facility Ventilation

5.6.2.1 Purpose AIR HANDLING SYSTEMS shall be maintained and operated by the owner/operator to protect the health and SAFETY of the facility's PATRONS.

5.6.2.2 Original Characteristics AIR HANDLING SYSTEMS shall be maintained and operated to comply with all requirements of the original system design, construction, and installation.

5.6.2.3 Indoor Facility Areas The AIR HANDLING SYSTEM operation and maintenance requirements shall apply to an INDOOR AQUATIC FACILITY including the AQUATIC VENUES, and the surrounding BATHER and spectator/STADIUM SEATING area.

5.6.2.3.1 Does Not Include The AIR HANDLING SYSTEM operation and maintenance requirements does not include:

1) Mechanical rooms,
2) Bath and locker rooms, and
3) Any associated rooms which have a direct opening to the AQUATIC FACILITY.

5.6.2.4 Ventilation Procedures The INDOOR AQUATIC FACILITY owner/operator shall develop and implement a program of STANDARD AIR HANDLING SYSTEM operation, maintenance, cleaning, testing, and inspection procedures with detailed instructions, necessary equipment and supplies, and oversight for those carrying out these duties, in accordance with the AIR HANDLING SYSTEM DESIGN PROFESSIONAL and/or manufacturer's recommendations.

5.6.2.4.1 System Operation The AIR HANDLING SYSTEM shall operate continuously, including providing the required amount of outdoor air.

5.6.2.4.1.1 Operation Outside of Operating Hours Exception During non-use periods, the amount of outdoor air may be reduced by no more than 50% as long as acceptable air quality is maintained.

5.6.2.5 Manuals/Commissioning Reports The QUALIFIED OPERATOR shall maintain a copy of the AIR HANDLING SYSTEM DESIGN PROFESSIONAL and/or manufacturer original operating manuals, commissioning reports, updates, and specifications for any modifications at the facility.

5.6.2.6 Ventilation Monitoring The QUALIFIED OPERATOR shall MONITOR, log, and maintain AIR HANDLING SYSTEM set-points and other operational parameters as specified by the AIR HANDLING SYSTEM DESIGN PROFESSIONAL and/or manufacturer.

5.6.2.7 Air Filter Changing The QUALIFIED OPERATOR shall replace or clean, as appropriate, AIR HANDLING SYSTEM air filters in accordance with the AIR HANDLING SYSTEM DESIGN PROFESSIONAL and/or manufacturer's recommendations, whichever is most frequent.

5.6.2.8[A] Combined Chlorine Reduction The QUALIFIED OPERATOR shall develop and implement a plan to minimize COMBINED CHLORINE compounds in the INDOOR AQUATIC FACILITY from the operation of AQUATIC VENUES.

5.6.2.9 Building Purge Plan The QUALIFIED OPERATOR shall develop and implement an air quality action plan with procedures for PURGING the INDOOR AQUATIC FACILITY for chemical emergencies or other indicators of poor air quality.

5.6.2.10 Records The owner shall ensure documents are maintained at the INDOOR AQUATIC FACILITY to be available for inspection, recording the following:

1) A log recording the set points of operational parameters set during the commissioning of the AIR HANDLING SYSTEM and the actual readings taken at least once daily;
2) Maintenance conducted to the system including the dates of filter changes, cleaning, and repairs;
3) Dates and details of modifications to the AIR HANDLING SYSTEM; and
4) Dates and details of modifications to the operating scheme.

5.6.3 Indoor / Outdoor Aquatic Facility Electrical Systems and Components

5.6.3.1[A] Electrical Repairs

5.6.3.1.1 Code Compliance Repairs or alterations to electrical equipment and associated equipment shall preserve compliance with the NEC or with all applicable local, state, territorial, federal, and tribal laws.

5.6.3.1.2 Immediately Repaired All defects in the electrical system shall be immediately repaired.

5.6.3.1.3 Wiring Electrical wiring, whether permanent or temporary, shall comply with the NEC and all applicable local, state, territorial, federal, and tribal laws.

5.6.3.2[A] Electrical Receptacles

5.6.3.2.1 New Receptacles The installation of new electrical receptacles shall be subject to electrical-construction requirements of this CODE and all applicable local, state, territorial, federal, and tribal laws.

5.6.3.2.2 Repairs Repairs or maintenance to existing receptacles shall maintain compliance with the NEC and with 29 CFR 1910.304(b) (3) (ii).

5.6.3.2.3 Replacement Replacement receptacles shall be of the same type as the previous ones (e.g., grounding-type receptacles shall be replaced only by grounding-type receptacles), with all grounding conductors connected and proper wiring polarity preserved.

5.6.3.2.4 Substitutions Where the original-type of receptacle is no longer available, a replacement and installation shall be in accordance with all applicable local, state, territorial, federal, and tribal laws.

5.6.3.3[A] Ground-Fault Circuit Interrupter

5.6.3.3.1 Manufacturer's Recommendations Where receptacles are required to be protected by GFCI devices, the GFCI devices shall be tested following the manufacturer's recommendations.

5.6.3.3.2 Testing Required GFCI devices shall be tested as part of scheduled maintenance on the first day of operation, and monthly thereafter, until the BODY OF WATER is drained and the equipment is prepared for STORAGE.

5.6.3.4[A] Grounding

5.6.3.4.1 Maintenance and Repair Maintenance or repair of electrical circuits or devices shall preserve grounding compliance with the NEC and all applicable local, state, territorial, federal, and tribal laws.

5.6.3.4.2 Grounding Conductors Grounding conductors that have been disconnected shall be re-inspected as required by the local building CODE authority prior to AQUATIC VENUE being used by BATHERS.

5.6.3.4.3 Damaged Conductors Damaged grounding conductors and grounding electrodes shall be repaired immediately.

5.6.3.4.4 Damaged Conductor Repair Damaged grounding conductors or grounding electrodes associated with recirculation or DISINFECTION equipment or with underwater lighting systems shall be repaired by a qualified person who has the proper and/or necessary skills, training, or credentials to carry out the task.

5.6.3.4.5 Public Access The public shall not have access to the AQUATIC VENUE until such grounding conductors or grounding electrodes are repaired.

5.6.3.4.6 Venue Closure The AQUATIC VENUE with damaged grounding conductors or grounding electrodes, that are associated with recirculation or DISINFECTION equipment or with underwater lighting systems, shall be closed until repairs are completed and then the AHJ inspects and approves.

5.6.3.5 Bonding

5.6.3.5.1 Code Compliance Maintenance or repair of all metallic equipment, electrical circuits or devices, or reinforced concrete structures shall preserve bonding compliance with the NEC and all applicable local, state, territorial, federal, and tribal laws.

5.6.3.5.2 Bonding Conductors Bonding conductors shall not be disconnected except where they will be immediately reconnected.

5.6.3.5.3 Disconnected Conductors The AQUATIC VENUE shall not be used by BATHERS while bonding conductors are disconnected.

5.6.3.5.4 Removable Covers Removable covers protecting bonding conductors (e.g., at ladders), shall be kept in place except during bonding conductor inspections, repair, or replacement.

5.6.3.5.5 Scheduled Maintenance Bonding conductors, where accessible, shall be inspected visually every 6 months or whenever disrupted or impacted by site construction or other related events.

5.6.3.5.6 Corrosion Bonding conductors and any associated clamps shall not be extensively corroded.

5.6.3.5.7 Continuity Continuity of the bonding system associated with RECIRCULATION SYSTEM or DISINFECTION equipment or with underwater lighting systems shall be inspected by the AHJ following installation and any major construction around the AQUATIC FACILITY.

5.6.3.6 Extension Cords

5.6.3.6.1 Extension Cords and Temporary Connectors Extension cords shall only be used temporarily for remodeling, maintenance, or repair of buildings, structures, or equipment with similar purposes. Extension cords and temporary power connectors shall not be used as a substitute for permanent wiring.

5.6.3.6.2 Minimum Distance from Water All parts of an extension cord shall be restrained at a minimum of 6 feet (1.8 m) away when measured along the shortest possible path from a BODY OF WATER during times when the AQUATIC FACILITY is open.

5.6.3.6.3[A] Exception An extension cord may be used within 6 feet (1.8 m) of the nearest edge of a BODY OF WATER if a permanent wall exists between the BODY OF WATER and the extension cord.

5.6.3.6.4 GFCI Protection The circuit supplying an extension cord shall be protected by a GFCI device when the extension cord is to be used within 6 feet (1.8 m) of a BODY OF WATER.

5.6.3.6.5 Code Compliance An extension cord incorporating a GFCI device may be used if that is acceptable under all applicable local, state, territorial, federal, and tribal laws.

5.6.3.6.6[A] Compliance The use of extension cords shall comply with 29 CFR 1910.304.

5.6.3.7 Portable Electric Devices Portable line-powered electrical devices, such as radios or drills, shall not be used within 6 feet (1.8 m) horizontally of the nearest inner edge of a BODY OF WATER, unless connected to a GFCI-protected circuit.

5.6.3.8[A] Communication Devices and Dispatch Systems The maintenance and repair of Communication Devices and Dispatch Systems shall preserve compliance with the NEC.

5.6.4 Facility Heating

5.6.4.1 Facility Heating

5.6.4.1.1[A] Maintenance and Repair Maintenance, repairs, and alterations to facility-heating equipment shall preserve compliance with applicable CODES.

5.6.4.1.2[A] Defects Defects in the AQUATIC FACILITY heating equipment shall be immediately repaired.

5.6.4.1.3[A] Temperature Air temperature of an INDOOR AQUATIC FACILITY shall be controlled to the original specifications or in the absence of such, maintain the dew point of the INTERIOR SPACE less than the

dew point of the interior walls at all times so as to prevent damage to structural members and to prevent biological growth on walls.

5.6.4.1.4 Combustion Device Items shall not be stored within the COMBUSTION DEVICE manufacturer's specified minimum clearance distance.

5.6.4.2 Water Heating Maintenance, repairs, and alterations to POOL-water heating equipment shall preserve compliance with applicable CODES.

5.6.5 First Aid Room [N/A]

5.6.6 Emergency Exit

5.6.6.1 Exit Routes Emergency exit routes shall be established for both INDOOR AQUATIC FACILITIES and outdoor AQUATIC FACILITIES and be maintained so that they are well lit, unobstructed, and accessible at all times. Emergency exits shall be clearly marked in accordance with MAHC 4.6.6.

5.6.7 Plumbing

5.6.7.1[A] Water Supply

5.6.7.1.1 Water Pressure All plumbing shall be maintained in good repair with no leaks or discharge.

5.6.7.1.2 Availability Potable water shall be available at all times to PATRONS.

5.6.7.1.3 Cross-Connection Control Water introduced into the POOL, either directly or to the RECIRCULATION SYSTEM, shall be supplied through an air gap or by another method which will prevent BACKPRESSURE and back-siphonage.

5.6.7.2 Drinking Fountains

5.6.7.2.1 Good Repair Drinking fountains shall be in good repair.

5.6.7.2.2 Clean Drinking fountains shall be clean.

5.6.7.2.3 Catch Basin Drinking fountains shall be adjusted so that water does not go outside the catch basin.

5.6.7.2.4 Contamination Drinking fountains shall provide an angled jet of water and be adjusted so that the water does not fall back into the drinking water stream.

5.6.7.2.5 Water Pressure Drinking fountains shall have sufficient water pressure to allow correct adjustment.

5.6.7.3[A] Wastewater

5.6.7.3.1 Wastewater Disposal AQUATIC VENUE wastewater, including backwash water and cartridge cleaning water, shall be disposed of in accordance with all applicable local, state, territorial, federal, and tribal laws.

5.6.7.3.2 Drainage Wastewater and backwash water shall not be returned to an AQUATIC VENUE or the AQUATIC FACILITY'S water treatment system.

5.6.7.3.3 Drain Line Filter backwash lines, DECK drains, and other drain lines connected to the AQUATIC FACILITY or the AQUATIC FACILITY RECIRCULATION SYSTEM shall be discharged through an approved air gap.

5.6.7.3.4 No Standing Water Discharge water shall not create any standing water, a nuisance, offensive odors, stagnant wet areas, or an environment for the breeding of insects.

5.6.7.4[A] Water Replenishment

5.6.7.4.1 Volume Removal of water from the POOL and replacement with make-up water shall be performed as needed to maintain water quality.

5.6.7.4.2 Discharged A volume of water totaling at least 4 gallons (15 L) per BATHER per day per AQUATIC VENUE shall be either:

1) Discharged from the system, or
2) Treated with an alternate system meeting the requirements of MAHC 4.7.4 and reused.

5.6.7.4.2.1 Backwash Water The required volume of water to be discharged may include backwash water.

5.6.7.4.3 Multi-System Facilities In multi-RECIRCULATION SYSTEM facilities, water replenishment shall be proportional to the number of BATHERS in each system.

5.6.8 Solid Waste Management

5.6.8.1 Storage Receptacles

5.6.8.1.1 Good Repair and Clean Outside waste and recycling containers shall be maintained in good repair and clean condition.

5.6.8.1.2 Storage Areas Outside waste and recycling STORAGE areas shall be maintained in good repair and clean condition.

5.6.8.2 Disposal

5.6.8.2.1 Frequency Solid waste and recycled materials shall be removed at a frequency to prevent attracting vectors or causing odor.

5.6.8.2.2 Code Compliance Solid waste and recycled materials shall be disposed of in compliance with all applicable local, state, territorial, federal, and tribal laws.

5.6.9 Decks

5.6.9.1 Food Preparation and Consumption

5.6.9.1.1 Preparation Food preparation and cooking shall only be permitted in designated areas as specified in this CODE.

5.6.9.1.2[A] Eating and Drinking BATHERS shall not eat or drink while in or partially in the AQUATIC VENUE water except in designated areas.

5.6.9.1.2.1 Swim-Up Bars Swim-up bars, when utilized, shall provide facilities for BATHERS to place food and drinks on a surface which can be SANITIZED.

5.6.9.2[A] Glass

5.6.9.2.1 Containers Glass food and beverage containers shall be prohibited in PATRON areas of AQUATIC FACILITIES.

5.6.9.2.2 Furniture Glass furniture shall not be used in an AQUATIC FACILITY.

5.6.9.3 Deck Maintenance

5.6.9.3.1[A] Free From Obstructions The PERIMETER DECK shall be maintained free from obstructions, including PATRON seating, to preserve space required for lifesaving and rescue.

5.6.9.3.2 Diaper Changing Diaper changing shall only be done at a designated DIAPER-CHANGING STATION.

5.6.9.3.2.1 Prohibited Diaper changing shall be prohibited on the DECK.

5.6.9.3.3[A] Vermin DECK areas shall be cleaned daily and kept free of debris, vermin, and vermin harborage.

5.6.9.3.4[A] Original Design DECK surfaces shall be maintained to their original design slope and integrity.

5.6.9.3.4.1[A] Crack Repair CRACKS in the DECK shall be part of the daily inspection process and be repaired when they change sufficiently to increase the potential for:

1) Trips or falls,
2) Lacerations, or
3) Impacting the ability to properly clean and maintain the DECK area.

5.6.9.3.5 Standing Water DECK areas shall be free from standing water.

5.6.9.3.6 Drains DECK drains shall be cleaned and maintained to prevent blockage and pooling of water.

5.6.9.3.7 Wet Areas Wet areas shall not have absorbent materials that cannot be removed for cleaning and DISINFECTION daily.

5.6.9.3.8 Circulation Path Fixed equipment, loose equipment, and DECK furniture shall not intrude upon the AQUATIC VENUE CIRCULATION PATH.

5.6.10 Aquatic Facility Maintenance All appurtenances, features, signage, and safety and other equipment and systems required by this CODE shall be provided and maintained.

5.6.10.1[A] Diving Boards and Platforms

5.6.10.1.1 Slip Resistant Finish The finish and profile of surfaces of diving boards and platforms shall be maintained to prevent slips, trips, and falls.

5.6.10.1.2 Loose Bolts and Cracked Boards Diving boards shall be inspected daily for CRACKS and loose bolts with CRACKED boards removed and loose bolts tightened immediately.

5.6.10.2 Steps and Guardrails

5.6.10.2.1 Immovable Steps and guardrails shall be secured so as not to move during use.

5.6.10.2.2 Maintenance The profile and surface of steps shall be maintained to reduce the likelihood of slips and falls.

5.6.10.3[A] Starting Platforms The profile and surface of starting platform steps shall be in good repair to prevent slips, trips, falls, and pinch hazards.

5.6.10.3.1 Starting Platform Use Deterrence Starting platform use by unqualified BATHERS shall be prohibited and prohibition shall be communicated by signage, covers, or other BARRIERS or deterrents.

5.6.10.4 Aquatic Features

5.6.10.4.1 Maintenance AQUATIC FEATURES shall be maintained and operated to manufacturer's/designer's specifications.

5.6.10.4.2 Slime and Biofilm Slime and biofilm layers shall be removed on all accessible AQUATIC FEATURE surfaces.

5.6.10.4.3 Flow Rates AQUATIC FEATURE water flow rates shall be checked to be within designer or manufacturer's specifications prior to opening to the public.

5.6.10.4.4 Disinfectant Where AQUATIC FEATURE plumbing lines are susceptible to holding stagnant water, AQUATIC FEATURE pumps shall be started with sufficient time prior to opening to flush such plumbing lines with treated water.

5.6.10.4.4.1 Water Testing The water shall be tested to verify the disinfectant in the water is within the parameters specified in MAHC 5.7.3.1.1.2.

5.6.10.5[A] Fencing, Enclosures, and Barriers

5.6.10.5.1 Maintenance Required fencing, ENCLOSURES, BARRIERS, and gates shall be maintained at all times.

5.6.10.5.2 Tested Daily Gates, locks, and associated alarms, if required, shall be tested daily prior to opening.

5.6.10.6[A] Aquatic Facility Cleaning

5.6.10.6.1 Cleaning The AQUATIC VENUE shall be kept clean of debris, organic materials, and slime/biofilm in accessible areas in the water and on surfaces.

5.6.10.6.2 Vacuuming Vacuuming shall only be done when the AQUATIC VENUE is closed.

5.6.10.6.3 Port Openings Vacuum port openings shall be covered with an approved device cover when not in use.

5.6.10.6.3.1 Damaged POOLS with missing or damaged vacuum port openings shall be closed and repairs made before reopening.

5.7 Recirculation and Water Treatment

5.7.1 Recirculation Systems and Equipment

5.7.1.1[A] General

5.7.1.1.1 Continuous Operation All components of the filtration and RECIRCULATION SYSTEMS shall be kept in continuous operation 24 hours per day.

5.7.1.1.1.1 Reduced Flowrates The system flowrate shall not be reduced more than 25% lower than the minimum design requirements and only reduced when the POOL is unoccupied during posted closure hours of the AQUATIC VENUE.

5.7.1.1.1.1.1 System Design The flow turndown system shall be designed as specified in MAHC 4.7.1.10.5.1–4.7.1.10.5.2.

5.7.1.1.1.1.2 Water Clarity The system flowrate shall be based on ensuring the minimum water clarity required under MAHC 5.7.6 is met and the turbidity level in the POOL is less than 0.5 NTU at all times while turning down the flow rate.

5.7.1.1.1.2 Disinfectant Concentration The turndown system shall be required to maintain required disinfectant concentration and pH at all times.

5.7.1.1.2 Flow Flow through the various components of a RECIRCULATION SYSTEM shall be balanced according to the provisions outlined in MAHC 5.7.1 to maximize the water clarity and SAFETY of a POOL.

5.7.1.1.3[A] Gutter / Skimmer Pools For gutter or SKIMMER POOLS with main drains, the required recirculation flow shall be the total design recirculation flow rate divided as follows during normal operation:

1) At least 80% of the total design recirculation flow rate through the Perimeter Overflow System, and

2) No greater than 20% of the total design recirculation flow rate through the main drain.

5.7.1.2 Combined Venue Treatment Each individual AQUATIC VENUE in a combined treatment system shall meet required TURNOVER TIMES specified in MAHC 5.7.1.9 and achieve all water quality criteria (including, but not limited to, pH, disinfectant concentration, and water clarity/turbidity).

5.7.1.3[A] Inlets INLETS shall be checked at least weekly for rate and direction of flow and adjusted as necessary to produce uniform circulation of water and to facilitate the maintenance of a uniform disinfectant residual throughout the POOL.

5.7.1.4 Surface Skimming Devices

5.7.1.4.1 Perimeter Overflow The Perimeter Overflow System shall be kept clean and free of debris that may restrict flow.

5.7.1.4.2 Automatic Fill System The automatic fill system, when installed, shall maintain the water level at an elevation such that the gutters must overflow continuously around the perimeter of the POOL.

5.7.1.4.3 Skimmer Water Levels The water levels shall be maintained near the middle of the SKIMMER openings.

5.7.1.4.4 Flow The flow through each SKIMMER shall be adjusted to maintain skimming action that will remove all floating matter from the surface of the water.

5.7.1.4.5 Strainer Baskets The strainer baskets for SKIMMERS shall be cleaned as necessary to maintain proper skimming.

5.7.1.4.6 Weirs Weirs shall remain in place and in working condition at all times.

5.7.1.4.6.1 Broken or Missing Weirs Broken or missing SKIMMER weirs shall be replaced immediately.

5.7.1.4.7 Flotation Test A flotation test may be required by the AHJ to evaluate the effectiveness of surface skimming.

5.7.1.5 Submerged Drains/Suction Outlet Covers or Gratings

5.7.1.5.1 Replaced Loose, broken, or missing suction outlet covers and sumps shall be secured or replaced immediately and installed in accordance with the manufacturer's requirements.

5.7.1.5.1.1 Closed POOLS shall be closed until the required repairs can be completed.

5.7.1.5.1.2 Close/Open Procedures AQUATIC FACILITIES shall follow procedures for closing and reopening whenever required as outlined in MAHC 5.4.1.

5.7.1.5.2 Documentation The manufacturer’s documentation on all outlet covers and sumps shall be made part of the permanent records of the AQUATIC FACILITY.

5.7.1.6[A] Piping Piping shall be marked in accordance with MAHC 4.9.1.5.1 and 4.9.1.5.2.

5.7.1.7 Strainers & Pumps Strainers shall be in place and cleaned as required to maintain pump performance.

5.7.1.8[A] Flow Meters Flow meters in accordance with MAHC 4.7.1.9.1 shall be provided and maintained in proper working order.

5.7.1.9 Flow Rates / Turnovers

5.7.1.9.1 New Construction or Substantially Altered Venues AQUATIC VENUES constructed or substantially altered after the adoption of this CODE shall be operated at the designed flow rate to provide the required TURNOVER RATE 24-hours per day except as allowed in MAHC 4.7.1.10.

5.7.1.9.2 Construction Before Adoption of this Code AQUATIC VENUES constructed before the adoption of this CODE shall be operated 24 hours per day at their designed flow rate.

5.7.2 Filtration

5.7.2.1 General

5.7.2.1.1 Certified, Listed, and Labeled Filters and filter media shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 or 61 by an ANSI-accredited certification organization.

5.7.2.1.2 Cleaned Filters shall be backwashed, cleaned, and maintained according to the manufacturer's instructions.

5.7.2.2 Granular Media Filters

5.7.2.2.1 Filtration Rates High-rate granular media filters shall be operated at no more than 15 GPM per square foot (36.7 m/h) when a minimum bed depth of 15 inches (38.1 cm) is provided per manufacturer's instructions.

5.7.2.2.1.1 Less than Fifteen Inch Bed Depth When a bed depth is less than 15 inches (38.1 cm), filters shall operate at no more than 12 GPM per square foot (29.3 m/h). Bed depth shall be measured from the top of the filter media to the top of the openings in the laterals (or underdrain system).

5.7.2.2.2 Backwashing Rates The granular media filter system shall be backwashed at a rate of at least 15 GPM per square foot (36.7 m/h) of filter bed surface area unless explicitly prohibited by the filter manufacturer and/or approved at an alternate rate as specified in the NSF/ANSI 50 listing as per MAHC 4.7.2.2.3.2.

5.7.2.2.3 Clear Water Backwashing should be continued until the water leaving the filter is clear.

5.7.2.2.4[A] Backwashing Frequency Backwashing of each filter shall be performed at a differential pressure increase over the initial clean filter pressure, as recommended by the filter manufacturer, unless the system can no longer achieve the design flow rate.

5.7.2.2.4.1[A] Backwash Scheduling Backwashes shall be scheduled to take place when the AQUATIC VENUE is closed for BATHER use.

5.7.2.2.4.1.1 Backwashing Without Bathers Present BATHERS shall not be permitted to reenter the AQUATIC VENUE until the RESPONSIBLE SUPERVISOR or QUALIFIED OPERATOR ensures that the recirculation pump and chemical feeders have restarted and run for a minimum of 5 minutes following completion of backwashing.

5.7.2.2.4.1.2 Backwashing With Bathers Present A filter may be backwashed while BATHERS are in the AQUATIC VENUE if all of the following criteria are met:

1) Multiple filters are used;
2) The filter to be backwashed can be isolated from the remaining RECIRCULATION SYSTEM and filters;
3) The recirculation and filtration system still continues to run as per this CODE;
4) The chemical feed lines inject at a point where chemicals enter the RECIRCULATION SYSTEM after the isolated filter and where they can mix as needed; and
5) The filtrate from the newly backwashed filter is diverted to a waste line for a time sufficient to pass one filter volume of water through the filter.

5.7.2.2.5 Filter Media Inspections Sand or other granular media shall be inspected for proper depth and cleanliness at least one time per year, replacing the media when necessary to restore depth or cleanliness.

5.7.2.2.6 Vacuum Sand Filters The manual air release valve of the filter shall be opened as necessary to remove any air that collects inside of the filter as well as following each backwash.

5.7.2.2.7[A] Filtration Enhancing Products Products used to enhance filter performance shall be used according to manufacturers' recommendations. Products used to enhance filter performance (e.g., clarifiers, flocculants, or products containing organic polyelectrolytes) shall not be used in combination with coagulants (e.g., products containing polyaluminum chloride to enhance filter performance).

5.7.2.3 Precoat Filters

5.7.2.3.1 Appropriate The appropriate media type and quantity as recommended by the filter manufacturer shall be used.

5.7.2.3.2[A] Return to the Aquatic Venue Precoating of the filters shall be required in closed loop (precoat) mode to minimize the potential for media or debris to be returned to the POOL.

5.7.2.3.3[A] Operation Filter operation shall be per manufacturer's instructions.

5.7.2.3.3.1 Uninterrupted Flow Flow through the filter shall not be interrupted when switching from precoat mode to filtration.

5.7.2.3.3.1.1 Flow Interruption When a flow interruption occurs on precoat filters not designed to bump, the media shall be backwashed out of the filter and a new precoat established according to the manufacturer's recommendations prior to BATHERS reentering the POOL.

5.7.2.3.3.2 Maximum Precoat Media Load Systems designed to flow to waste while precoating shall use the maximum recommended precoat media load permitted by the filter manufacturer to account for media lost to the waste stream during precoating.

5.7.2.3.4[A] Cleaning Backwashing or cleaning of filters shall be performed at a differential pressure increase over the initial clean filter pressure as recommended by the filter manufacturer unless the system can no longer achieve the design flow rate.

5.7.2.3.5 Continuous Feed Equipment Continuous filter media feed equipment tank agitators shall run continuously.

5.7.2.3.5.1 Batch Application Filter media feed may also be performed via batch application.

5.7.2.3.6[A] Bumping Bumping a precoat filter shall be performed in accordance with the manufacturer's recommendations.

5.7.2.3.7[A] Filter Media

5.7.2.3.7.1[A] Diatomaceous Earth Diatomaceous earth (DE), when used, shall be added to precoat filters in the amount recommended by the filter manufacturer.

5.7.2.3.7.2 Perlite Perlite, when used, shall be added to precoat filters in the amount recommended by the filter manufacturer and in accordance with the specifications for the filter listing and labeling to NSF/ANSI 50 by an ANSI-accredited certification organization.

5.7.2.4 Cartridge Filters

5.7.2.4.1[A] Approved Cartridge filters shall be operated in accordance with the filter manufacturer's recommendation and be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization.

5.7.2.4.2[A] Filtration Rates The maximum operating filtration rate for any surface-type cartridge filter shall not:

1) Exceed the lesser of either the manufacturer's recommended filtration rate or 0.375 GPM per square foot (0.26 L/s/m2) or

2) Drop below the design flow rate required to achieve the TURNOVER RATE for the AQUATIC VENUE.

5.7.2.4.3[A] Filter Elements Active filter cartridges shall be exchanged with clean filter cartridges at a differential pressure increase over the initial clean filter pressure as recommended by the filter manufacturer unless the system can no longer achieve the design flow rate.

5.7.2.4.3.1[A] Cleaning Procedure The filter housing and filter cartridge shall be cleaned per manufacturer's recommendation.

5.7.2.4.3.1.1 No Manufacturer Procedure If there is no established manufacturer cleaning procedure, then filters shall be cleaned per MAHC 5.7.2.4.3.2 and 5.7.2.4.3.3.

5.7.2.4.3.2 Filter Housing Cleaning The following procedures shall be implemented to clean the filter housing when no manufacturer instructions are established:

1) Drain filter housing to waste;
2) Remove the filter cartridges from the housing;
3) Clean the inside of the filter housing with a brush and mild detergent to remove biofilms and algae;
4) Rinse thoroughly; and
5) Mist the filter housing walls with CHLORINE bleach at a 1:10 dilution.

5.7.2.4.3.3 Filter Cartridge Cleaning The following procedures shall be implemented to clean the filter cartridge when no manufacturer instructions are established.

5.7.2.4.3.3.1 Rinse Thoroughly The cartridge shall be rinsed thoroughly with a spray nozzle.

5.7.2.4.3.3.2[A] Pressure Washer A pressure washer shall not be used to clean cartridge filters.

5.7.2.4.3.3.3 Degrease Cartridge filters shall be degreased each time they are cleaned per the procedures outlined in this section.

5.7.2.4.3.3.4 Soak The cartridge shall be soaked overnight in one of the following solutions:

1) A cartridge filter cleaner/degreaser per instructions on product label,
2) A solution of water with 1 cup (240 mL) of tri-sodium phosphate (TSP) per 5 gallons (18.9 L) of water, or
3) One cup (240 mL) of automatic dishwashing detergent per 5 gallons (18.9 L) of water.

5.7.2.4.3.3.5 Acid Muriatic acid or products with acid in them shall never be used prior to degreasing.

5.7.2.4.3.3.6 Rinse The filter cartridge shall be removed from the degreaser solution and rinsed thoroughly.

5.7.2.4.3.3.7 Sanitize The filter cartridge shall be SANITIZED by soaking for 1 hour in a bleach solution made by mixing 1 quart (950 mL) of household bleach per 5 gallons (18.9 L) of water.

5.7.2.4.3.3.8 Rinse After soaking for 1 hour, the SANITIZED filter cartridge shall be removed and rinsed thoroughly.

5.7.2.4.4 Spare Cartridge One full set of spare cartridges shall be maintained onsite in a clean and dry condition.

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

5.7.3.1 Primary Disinfectants Only the primary disinfectants outlined in MAHC 5.7.3 shall be acceptable for use in AQUATIC VENUES.

5.7.3.1.1[A] Chlorine (Hypochlorites)

5.7.3.1.1.1 EPA Registered Only CHLORINE products that are EPA REGISTERED for use as SANITIZERS or disinfectants in AQUATIC VENUES or SPAS in the United States shall be permitted.

5.7.3.1.1.2[A] Minimum DPD-FC Concentrations Minimum DPD-FC concentrations shall be maintained at all times in all areas as follows in MAHC 5.7.3.1.1.2.1 to 5.7.3.1.1.2.3.

5.7.3.1.1.2.1 Not Using Cyanuric Acid AQUATIC VENUES not using CYA shall maintain a minimum DPD-FC concentration of 1.0 ppm (mg/L).

5.7.3.1.1.2.2 Using Cyanuric Acid AQUATIC VENUES using CYA shall maintain a minimum DPD-FC concentration of 2.0 ppm (mg/L).

5.7.3.1.1.2.3 Spas SPAS shall maintain a minimum DPD-FC concentration of 3.0 ppm (mg/L).

5.7.3.1.1.3 Stagnant Water Lines Recirculated AQUATIC FEATURE water lines susceptible to holding stagnant water shall maintain disinfectant throughout the lines as per MAHC 5.7.3.1.1.2.

5.7.3.1.1.4 Consistent with Label Instructions DPD-FC concentrations shall be consistent with label instructions.

5.7.3.1.1.5[A] Maximum DPD-FC Concentrations The upper operating range for Cl products is dictated by the manufacturer's instructions for use, in compliance with EPA FIFRA. Maximum DPD-FC concentrations shall not exceed limits specified on the product label.

5.7.3.1.2 Bromine

5.7.3.1.2.1[A] EPA Registered Only bromine products that are EPA REGISTERED for use as SANITIZERS or disinfectants in AQUATIC VENUES or SPAS in the United States shall be permitted.

5.7.3.1.2.1.1 Disinfectants 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)).

5.7.3.1.2.2[A] Minimum Bromine Concentrations Minimum bromine concentrations shall be maintained at all times in all areas as follows:

1) All AQUATIC VENUES: 3.0 ppm (mg/L), and
2) SPAS: 4.00 ppm (mg/L).

5.7.3.1.2.3[A] Maximum Bromine Concentrations The maximum bromine concentration shall not exceed 8.0 ppm (mg/L) at any time the AQUATIC VENUE is open to BATHERS.

5.7.3.1.3 Stabilizers CYA or stabilized CHLORINE products shall be CERTIFIED, LISTED, AND LABELED to either NSF/ANSI 50 or NSF/ANSI 60 by an ANSI-accredited certification organization, and/or have an EPA FIFRA registration.

5.7.3.1.3.1[A] Cyanuric Acid CYA or stabilized CHLORINE products shall not be used at the following for all new construction, SUBSTANTIAL ALTERATION, or DISINFECTION equipment replacements after the effective date of this CODE:

1) SPAS and
2) Therapy pools.

5.7.3.1.3.1.1 Replacement Times These AQUATIC VENUES shall no longer use CYA or stabilized CHLORINE products no later than 4 years after adoption of this CODE.

5.7.3.1.3.2 Aquatic Venues The CYA concentration at all AQUATIC VENUES shall remain at or below 90 ppm (mg/L).

5.7.3.1.3.3 Remediation If the CYA level is determined to be 300 ppm (mg/L) or higher, the AQUATIC VENUES shall remain closed until immediate remediation has occurred.

5.7.3.1.4[A] Compressed Chlorine Gas As per MAHC 4.7.3.2.4.1, use of compressed CHLORINE gas shall be prohibited for new construction and after SUBSTANTIAL ALTERATION to existing AQUATIC FACILITIES.

5.7.3.1.4.1 Safety Requirements Facilities using compressed CHLORINE gas shall provide SAFETY precautions per the following MAHC subsections.

5.7.3.1.4.1.1 Separate Enclosure The chlorinators and any cylinders containing CHLORINE gas used therewith shall be housed in an ENCLOSURE separated from other EQUIPMENT ROOMS, including the swimming POOL, corridors, dressing rooms and other space.

5.7.3.1.4.1.1.1 Door The chlorinators and any cylinders containing CHLORINE gas used therewith shall be housed in an ENCLOSURE with a door so installed as to prevent gas leakage and equipped with an inspection window.

5.7.3.1.4.1.2 Secured CHLORINE cylinders shall be secured from falling.

5.7.3.1.4.1.3 Cylinders in Use Cylinders in use shall be secured on a suitable platform scale.

5.7.3.1.4.1.4 Vent to Exterior A separate vent opening to the exterior shall be provided.

5.7.3.1.4.1.5 Fan An electric motor-driven fan shall take suction from near the floor level of the ENCLOSURE and discharge at a suitable point to the exterior above the ground level.

5.7.3.1.4.1.5.1 Fan Switch The fan switch shall be able to be operated from outside of the ENCLOSURE.

5.7.3.1.4.1.6 Trained Operator Any person who operates such chlorinating equipment shall be trained in its use.

5.7.3.1.4.1.7 Stop Use Facilities shall stop the use of CHLORINE gas if specific safety equipment and training requirements, along with all applicable local, state, territorial, federal, and tribal laws, cannot be met.

5.7.3.1.5[A] Salt Electrolytic Chlorine Generators, Brine Electrolytic Chlorine or Bromine Generators

5.7.3.1.5.1 Pool Grade Salt Only POOL grade salt that has been CERTIFIED, LISTED, AND LABELED to either NSF/ANSI 50 or NSF/ANSI 60 by an ANSI-accredited certification organization, and/or have an EPA FIFRA registration shall be used.

5.7.3.1.5.2 Maintained The saline content of the POOL water shall be maintained in the required range specified by the manufacturer.

5.7.3.1.5.3 Cleaning Cleaning of electrolytic plates shall be performed as recommended by the manufacturer.

5.7.3.1.5.4 Corrosion Protection Corrosion protection systems shall be maintained in the POOL basin.

5.7.3.2[A] 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.

5.7.3.2.1.1.1 Response to Interruption in Operation Any interruptions in UV system operations that are triggered by an interlock per MAHC 4.7.3.2.5.6.2 shall be evaluated as possible evidence for low flow

state of the AQUATIC VENUE pumps, prompting BATHER evacuation according to MAHC 5.7.3.5.1.2.1 and BATHER reentry according to MAHC 5.7.3.5.1.2.2.

5.7.3.2.1.2[A] 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.

5.7.3.2.1.3 Free Available Chlorine and Bromine Concentrations Use of UV does not modify any other water quality requirements.

5.7.3.2.1.4[A] Calibrated Sensors UV sensors shall be calibrated at a frequency in accordance with manufacturer recommendations.

5.7.3.2.1.5 Records Records of calibration shall be maintained by the facility.

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.

5.7.3.2.2.2 Residual Ozone Concentration Residual ozone concentration in the AQUATIC VENUE water shall remain below 0.1 ppm (mg/L).

5.7.3.2.2.3 Free Available Chlorine and Bromine Concentrations Use of ozone does not modify any other water quality requirements.

5.7.3.2.2.4 Standard Operating Manual 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.

5.7.3.2.2.5 Employees Trained All employees shall be properly trained in the operation and maintenance of the equipment.

5.7.3.2.2.6 Response to Interruption in Operation Any interruptions in ozone system operations that are triggered by an interlock per MAHC 4.7.3.2.5.6.2 shall be evaluated as possible evidence for low flow state of the AQUATIC VENUE pumps, prompting BATHER evacuation according to MAHC 5.7.3.5.1.2.1 and BATHER reentry according to MAHC 5.7.3.5.1.2.2.

5.7.3.2.3[A] Copper / Silver Ions

5.7.3.2.3.1 EPA Registered Only those systems that are EPA REGISTERED for use as SANITIZERS or disinfectants in AQUATIC VENUES or SPAS in the United States are permitted.

5.7.3.2.3.2 Concentrations Copper and silver concentrations shall not exceed 1.3 ppm (mg/L) for copper and 0.10 ppm (mg/L) for silver for use as disinfectants in AQUATIC VENUES and SPAS in the United States.

5.7.3.2.3.3 DPD-FC and Bromine Concentrations DPD-FC or bromine concentrations shall be maintained in accordance with MAHC 5.7.3.1.1 or 5.7.3.1.2, respectively.

5.7.3.3[A] Other Sanitizers, Disinfectants, or Chemicals Other SANITIZERS, disinfectants, or chemicals used shall:

1) Be EPA REGISTERED under FIFRA if they are pesticides as defined by EPA,
2) Not create a hazardous condition or compromise disinfectant efficacy when used with required bromine or CHLORINE concentrations, and
3) Not interfere with water quality measures meeting all criteria set forth in this CODE.

5.7.3.3.1[A] Chlorine Dioxide Chlorine dioxide shall only be used for remediation for water quality issues when the AQUATIC VENUE is closed and BATHERS are not present.

5.7.3.3.1.1 Safety Considerations SAFETY training and SAFETY precautions related to use of chlorine dioxide shall be in place.

5.7.3.3.2[A] Clarifiers, Flocculants, Defoamers Clarifiers, flocculants, and defoamers shall be used per manufacturer's instructions.

5.7.3.3.2.1 Certified, Listed, and Labeled Clarifiers, flocculants, and defoamers shall CERTIFIED, LISTED, AND LABELED to either NSF/ANSI 50 or NSF/ANSI 60 by an ANSI-accredited certification organization.

5.7.3.4[A] pH

5.7.3.4.1 pH Range The pH of the water shall be maintained at 7.0 - 7.8.

5.7.3.4.2 Approved Substances Approved substances for pH adjustment shall include but not be limited to muriatic (hydrochloric) acid, sodium bisulfate, carbon dioxide, sulfuric acid, sodium bicarbonate, and soda ash.

5.7.3.4.2.1 Certified, Listed, and Labeled Chemicals used for pH adjustment shall be CERTIFIED, LISTED, AND LABELED to either NSF/ANSI 50 or NSF/ANSI 60 by an ANSI-accredited certification organization.

5.7.3.5[A] Feed Equipment

5.7.3.5.1 Acceptable Chemical Delivery Acceptable disinfectant and pH control chemicals shall be delivered through an automatic chemical feed system upon adoption of this CODE.

5.7.3.5.1.1 Dedicated and Labeled Components All chemical feed system components shall be dedicated to a single chemical and clearly labeled to prevent the introduction of incompatible chemicals.

5.7.3.5.1.2[A] Installed and Interlocked Chemical feed system components shall be installed and interlocked so the chemical feeder cannot operate when the RECIRCULATION SYSTEM is in low or no flow circumstances as per MAHC 4.7.3.2.1.3.

5.7.3.5.1.2.1 Response to Alarm and Bather Evacuation When the interlock is activated stopping flow from chemical feeders per MAHC 4.7.3.2.1.3 and 5.7.3.5.1.3, or the water recirculation pump is stopped manually or unexpectedly for any reason and duration, including power outages, all BATHERS shall be evacuated from the AQUATIC VENUE until manual evaluation of the cause for interlock activation or recirculation pump interruption is completed by the RESPONSIBLE SUPERVISOR or QUALIFIED OPERATOR.

5.7.3.5.1.2.2[A] Bather Reentry BATHERS shall not be permitted to reenter the AQUATIC VENUE until the RESPONSIBLE SUPERVISOR or QUALIFIED OPERATOR has successfully understood the cause of the interlock activation and/or recirculation pump interruption and has manually overridden the interlock for restart of the recirculation pump and chemical feeder, and UV or ozone system, if applicable, for 5 minutes following the restart of these systems.

5.7.3.5.1.3 Fail Proof Safety Features Chemical feed system components shall incorporate failure-proof features so the chemicals cannot feed directly into the AQUATIC VENUE, the VENUE piping system not associated with the RECIRCULATION SYSTEM, source water supply system, or area within proximity of the AQUATIC VENUE DECK under any type of failure, low flow, or interruption of operation of the equipment to prevent BATHER exposure to high concentrations of AQUATIC VENUE treatment chemicals.

5.7.3.5.1.4 Maintained All chemical feed equipment shall be maintained in good working condition.

5.7.3.5.1.4.1 Challenge Testing The system and its components shall be tested on a regular basis to confirm that all SAFETY features are functioning correctly.

5.7.3.5.1.4.1.1 Once Monthly or Specified by Manufacturer Unless specified otherwise by the device manufacturer, once monthly challenge testing of the chemical feeder interlock system shall be conducted by turning off recirculation pump flow to the chemical feeder and ensuring triggered shutoff of chemical feeder occurs via electrical interlock with flow meter/flow switch, paddle wheel, or other device being used to assess flow to chemical feeder.

5.7.3.5.1.4.1.2 Following Confirmation Following confirmation of triggered shutoff, recirculation flow shall immediately be restarted.

5.7.3.5.1.5 Insufficient Size/Capacity If it is determined that the chemical feed system is incapable of maintaining the minimum required disinfectant concentration at all times in accordance with the MAHC, additional capacity shall be designed and installed per MAHC 4.7.3.2.2.

5.7.3.5.2 Chemical Feeders Chemical feeders shall be installed such that they are not over chemical storage containers, other feeders, or electrical equipment.

5.7.3.5.3 Dry Chemical Feeders Chemicals shall be kept dry to avoid clumping and potential feeder plugging for mechanical gate or rotating screw feeders.

5.7.3.5.3.1 Cleaned and Lubricated The feeder mechanism shall be cleaned and lubricated to maintain a reliable feed system.

5.7.3.5.4 Venturi Inlet Adequate pressure shall be maintained at the venturi INLET to create the vacuum needed to draw the chemical into the RECIRCULATION SYSTEM.

5.7.3.5.5 Erosion Feeders Erosion feeders shall only have chemicals added that are approved by the manufacturer.

5.7.3.5.5.1 Opened A feeder shall only be opened after the internal pressure is relieved by a bleed valve.

5.7.3.5.5.2 Maintained Erosion feeders shall be maintained according to the manufacturer's instructions.

5.7.3.5.6 Liquid Solution Feeders For liquid solution feeders, spare feeder tubes (or tubing) shall be maintained onsite for peristaltic pumps.

5.7.3.5.7 Checked Daily All chemical tubing, connections, support, and double containment piping shall be checked on a daily basis for leaks.

5.7.3.5.7.1 Routed All chemical tubing that runs through areas where staff work shall be routed in PVC piping to support the tubing and to prevent leaks.

5.7.3.5.7.1.1 Size The double containment PVC pipe shall be of sufficient size to allow for easy replacement of tubing.

5.7.3.5.7.1.2 Turns Any necessary turns in the piping shall be designed so as to prevent kinking of the tubing.

5.7.3.5.8 Gas Feed Systems The Chlorine Institute Pamphlet 82 requirements for safe STORAGE and use of CHLORINE gas shall be followed.

5.7.3.5.9 Carbon Dioxide Carbon dioxide feed shall be permitted to reduce pH.

5.7.3.5.9.1 Controlled Carbon dioxide feed shall be controlled using a gas regulator.

5.7.3.5.9.2 Alarm Monitor CO2/O2 monitor and alarm shall be maintained in working condition.

5.7.3.5.9.3 Forced Ventilation Carbon dioxide is heavier than air, so forced ventilation shall be maintained in the STORAGE room.

5.7.3.6 Testing for Water Circulation and Quality

5.7.3.6.1 Water Quality Testing Devices Available WQTDs for the measurement of disinfectant residual, pH, alkalinity, CYA (if used), and temperature, at a minimum, shall be available onsite.

5.7.3.6.1.1 Expiration Dates WQTDs utilizing reagents shall be checked for expiration at every use and the date recorded.

5.7.3.6.2 Store WQTDs shall be stored in accordance with manufacturer's instructions.

5.7.3.6.3 Temperature Chemical testing reagents shall be maintained at proper manufacturer specified temperatures.

5.7.3.6.4 Calibration WQTDs that require calibration shall be calibrated in accordance with manufacturer's instructions and the date of calibration recorded.

5.7.3.7 Automated Controllers and Equipment Monitoring

5.7.3.7.1 Use of Controller An AUTOMATED CONTROLLER capable of measuring the disinfectant residual (DPD-FC or bromine) or surrogate such as ORP shall be used to maintain the disinfectant residual in AQUATIC VENUES as outlined in MAHC 4.7.3.2.8.

5.7.3.7.1.1 Installed An AUTOMATED CONTROLLER shall be required within 1 year from time of adoption of this CODE.

5.7.3.7.1.2 Interlocked AUTOMATED CONTROLLERS shall be interlocked per MAHC 4.7.3.2.1.3 upon adoption of this CODE if existing or upon installation if not existing.

5.7.3.7.2 Sampling The sample line for all probes shall be upstream from all primary, SECONDARY and SUPPLEMENTAL TREATMENT injection ports or devices.

5.7.3.7.3 Monitor AUTOMATED CONTROLLERS shall be MONITORED in person by visual observation at the start of the operating day to ensure proper functioning.

5.7.3.7.4 Activities MONITORING shall include activities recommended by manufacturers, including but not limited to alerts and leaks.

5.7.3.7.5 Replacement Parts Only manufacturer-approved OEM replacement parts shall be used.

5.7.3.7.6 Calibration AUTOMATED CONTROLLERS shall be calibrated per manufacturer directions.

5.7.3.7.7[A] Ozone System When an ozone system is utilized as a SECONDARY TREATMENT, 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

5.7.3.7.7.1 Other 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 by volume (ppmv or mL/m3) gaseous ozone.

5.7.3.7.7.1.1 Results Results of the test shall be maintained onsite for review by the AHJ.

5.7.3.7.8[A] UV Systems When a UV system is utilized as a SECONDARY TREATMENT, 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 (Medium Pressure)	Continuous	Daily
Set Point for Intensity Monitoring	Continuous	Daily
UV Lamp On/Off Cycle Monitoring	Continuous	Weekly (Total Cycles/Week)
Iron, Calcium Hardness Monitoring	Weekly (If Fouling is Prevalent)	Weekly
Calibration of UVT Analyzer (if used)	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

5.7.3.7.9 UV Alarm Testing and Maintenance The automated UV shut-down alarm required in MAHC 4.7.3.3.3.6 shall be tested weekly and maintained as needed.

5.7.4 Water Sample Collection and Testing

5.7.4.1 Sample Collection The QUALIFIED OPERATOR shall ensure a water sample is acquired for testing from the in-line sample port when available as per MAHC 5.7.5.

5.7.4.1.1 Same Volume If an AQUATIC VENUE has more than one RECIRCULATION SYSTEM, the same sample volume shall be collected from each in-line sample port and tested separately.

5.7.4.1.2 No Port If no in-line sample port is available, the QUALIFIED OPERATOR shall ensure water samples from the AQUATIC VENUE are acquired according to MAHC 5.7.4.3.

5.7.4.2 Routine Samples If routine samples are collected from in-line sample ports, the QUALIFIED OPERATOR shall also ensure water samples are acquired from the bulk water of the AQUATIC VENUE at least once per day.

5.7.4.2.1 Midday Collection Daily bulk water samples shall be collected in the middle of the AQUATIC VENUE operational day, according to the procedures in MAHC 5.7.4.3.

5.7.4.2.2 Compared Water quality data from these AQUATIC VENUE samples shall be compared to data obtained from in-line port samples to assess potential water quality variability in the AQUATIC VENUE.

5.7.4.3[A] Bulk Water Sample The QUALIFIED OPERATOR shall ensure the following procedure is used for acquiring a water sample from bulk water of the POOL.

5.7.4.3.1 Obtain Sample All samples shall be obtained from a location with the following qualities:

1) At least 18 inches (45.7 cm) below the surface of the water,
2) A water depth of 3–4 feet (91.4 cm to 1.2 m) when available, and
3) A location between water INLETS.

5.7.4.3.2 Rotate Sampling locations shall rotate around the shallow end of the POOL.

5.7.4.3.3 Deepest Area The QUALIFIED OPERATOR shall ensure a sample includes a deep end sample from the AQUATIC VENUE in the water sampling rotation once per week.

5.7.4.4[A] Aquatic Venue Water Chemical Balance

5.7.4.4.1[A] Total Alkalinity Total alkalinity shall be maintained in the range of 60 to 180 ppm (mg/L).

5.7.4.4.2[A] Combined Chlorine (Chloramines) The owner shall ensure the AQUATIC FACILITY takes action to reduce the concentration of COMBINED CHLORINE (chloramines) in the water when the concentration exceeds 0.4 ppm (mg/L). Such actions may include but are not limited to:

1) Superchlorination,
2) Water exchange, or
3) PATRON adherence to appropriate BATHER hygiene practices.

5.7.4.4.3[A] Calcium Hardness Calcium hardness shall not exceed 2500 ppm (mg/L).

5.7.4.4.4[A] Algaecides Algaecides may be used in an AQUATIC VENUE provided:

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; and
3) The product is registered with the EPA and applicable state agency.

5.7.4.5[A] Source (Fill) Water 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:

1) The water comes from a PUBLIC WATER SYSTEM as defined by the applicable rules of the AHJ in which the facility is located;
2) The water meets the requirements of the AHJ for PUBLIC WATER SYSTEMS; or
3) The AHJ has approved an alternative water source for use in the AQUATIC FACILITY.

5.7.4.6[A] Water Balance for Aquatic Venues AQUATIC VENUE water shall be chemically balanced.

5.7.4.7[A] Water Temperature

5.7.4.7.1 Minimize Risk and Protect Safety Water temperatures shall be considered and planned for based on risk, SAFETY, priority facility usage, and age of participants, while managing water quality concerns.

5.7.4.7.2[A] Maximum Temperature The maximum temperature for an AQUATIC VENUE is 104º F (40°C).

5.7.5[A] Water Quality Chemical Testing Frequency

5.7.5.1[A] Chemical Parameters DPD-FC, COMBINED AVAILABLE CHLORINE (CAC), or TOTAL BROMINE (TB), and pH shall be tested at all AQUATIC VENUES prior to opening each day.

5.7.5.2 Manual Disinfectant Feed System For all AQUATIC VENUES using a manual disinfectant feed system that delivers disinfectant via a flow through erosion feeder or metering pump without an AUTOMATED CONTROLLER, DPD-FC or bromine and pH shall be tested prior to opening to the public and every 2 hours while open to the public.

5.7.5.3 Automatic Disinfectant Feed System For all AQUATIC VENUES using an automated disinfectant feed system, DPD-FC (or TB) and pH shall be tested prior to opening and every 4 hours while open to the public.

5.7.5.4 In-Line ORP Readings In-line ORP readings, if such systems are installed, shall be recorded at the same time the DPD-FC (or TB) and pH tests are performed.

5.7.5.5 Total Alkalinity Total Alkalinity (TA) shall be tested weekly at all AQUATIC VENUES.

5.7.5.6 Calcium Hardness Calcium hardness shall be tested monthly at all AQUATIC VENUES.

5.7.5.7 Cyanuric Acid CYA shall be tested monthly at all AQUATIC VENUES utilizing CYA.

5.7.5.7.1 Tested CYA shall be tested 24 hours after the addition of CYA to the AQUATIC VENUE.

5.7.5.7.2 Stabilized Chlorine If AQUATIC VENUES utilize stabilized CHLORINE as its primary disinfectant, the operator shall measure CYA concentrations weekly or more frequently as necessary to ensure compliance with MAHC 5.7.3.

5.7.5.8 Saturation Index The SATURATION INDEX shall be checked monthly.

5.7.5.9 Total Dissolved Solids TDS shall be tested quarterly at all AQUATIC VENUES.

5.7.5.10 Water Temperature For heated AQUATIC VENUES, water temperature shall be recorded at the same time the DPD-FC (or TB) and pH tests are performed.

5.7.5.11 Salt If in-line electrolytic chlorinators are used, salt concentrations shall be tested at least weekly or per manufacturer's instructions.

5.7.5.12 Copper/Silver Systems Copper and silver shall be tested daily at all AQUATIC VENUE utilizing copper/silver systems as a SUPPLEMENTAL TREATMENT system.

5.7.6[A] Water Clarity

5.7.6.1 Water Clarity The water in an AQUATIC VENUE shall be sufficiently clear such that the bottom is visible while the water is static at all times the AQUATIC VENUE is open or available for use.

5.7.6.1.1 Reference Tile The reference tile required in MAHC 4.5.1.2.1 through 4.5.1.2.4 shall be used to observe water clarity.

5.7.6.1.2 No Reference Tile In the absence of a reference tile or suction outlet, an alternate means of achieving the goal of observing the bottom of the pool may be permitted.

5.7.6.2 Visible This reference point shall be visible at all times at any point on the DECK up to 30 feet (9.1 m) away in a direct line of sight from the tile or main drain.

5.7.6.2.1 Spas For SPAS, this test shall be performed when the water is in a non-turbulent state and bubbles have been allowed to dissipate.

5.8 Decks and Equipment

5.8.1[A] Deck Areas

5.8.1.1 Cross-Connection Control

5.8.1.1.1 Deck Drains BACKPRESSURE prevention devices shall be in good working order, and shall be tested as required by the AHJ.

5.8.1.2 Materials / Slip Resistant

5.8.1.2.1 Clean and Good Repair Surfaces shall be clean and in good repair.

5.8.1.2.2 Risk Management The finish and profile of DECK surfaces shall be maintained to prevent slips and falls.

5.8.1.2.3[A] Tripping Hazards Tripping hazards shall be avoided.

5.8.1.2.3.1 Protect If tripping hazards are present, they shall be repaired or promptly barricaded to protect PATRONS/employees.

5.8.1.3 Deck Size/Width The PERIMETER DECK shall be maintained clear of obstructions for at least a 4 foot (1.2 m) width around the entire POOL unless otherwise allowed by this CODE.

5.8.2 Diving Boards and Platforms [N/A]

5.8.3[A] Starting Platforms

5.8.3.1 Competitive Training and Competition Starting platforms shall only be used for competitive swimming and training.

5.8.3.1.1 Supervision Starting platforms shall only be used under the direct supervision of a coach or instructor.

5.8.3.1.2 Removed or Restricted Starting platforms shall be removed, if possible, or prohibited from use during all recreational or non-competitive swimming activity by covering platforms with a manufacturer-supplied platform cover or with another means or device that is readily visible and clearly prohibits use.

5.8.4 Pool Slides [N/A]

5.8.5 Lifeguard- and Safety-Related Equipment

5.8.5.1[A] Equipment Inspection and Maintenance AQUATIC FACILITIES shall not be open to users unless the equipment listed under MAHC 5.8.5 is present and in a safe and working condition.

5.8.5.2 Safety Equipment Required at All Aquatic Facilities

5.8.5.2.1 Emergency Communication Equipment

5.8.5.2.1.1[A] Functioning Communication Equipment The AQUATIC FACILITY shall have equipment for staff to communicate in cases of emergency.

5.8.5.2.1.2[A] Hard-Wired Telephone for 911 Call The AQUATIC FACILITY or each AQUATIC VENUE, as necessary, shall have a functional telephone or other communication system or device that is hard wired and capable of directly dialing 911 or function as the emergency notification system.

5.8.5.2.1.3 Conspicuous and Easily Accessible The telephone or communication system or device shall be conspicuously provided and accessible to AQUATIC VENUE users such that it can be reached immediately.

5.8.5.2.1.4[A] Alternate Communication Systems Alternate functional systems, devices, or communication processes are allowed with AHJ approval in situations when a hardwired telephone is not logistically sound, and an alternate means of communication is available.

5.8.5.2.2 First Aid Equipment

5.8.5.2.2.1[A] Location for First Aid The AQUATIC FACILITY shall have designated locations for emergency and first aid equipment.

5.8.5.2.2.2[A] First Aid Supplies An adequate supply of first aid supplies shall be continuously stocked and include, at a minimum, as follows:

1) A first aid guide,
2) Absorbent compress,
3) Adhesive bandages,
4) Adhesive tape,
5) Sterile pads,
6) Disposable gloves,
7) Scissors,
8) Elastic wrap,
9) Emergency blanket,
10) Resuscitation mask with one-way valve, and
11) Blood-borne pathogen spill kit.

5.8.5.2.3 Signage

5.8.5.2.3.1[A] Sign Indicating First Aid Location Signage shall be provided at the AQUATIC FACILITY or each AQUATIC VENUE, as necessary, which clearly identifies the following:

1) First aid location(s) and
2) Emergency telephone(s) or approved communication system or device.

5.8.5.2.3.2[A] Emergency Dialing Instructions A permanent sign providing emergency dialing directions and the AQUATIC FACILITY address shall be posted and maintained at the emergency telephone, system, or device.

5.8.5.2.3.3[A] Management Contact Info A permanent sign shall be conspicuously posted and maintained displaying contact information for emergency personnel and AQUATIC FACILITY management.

5.8.5.2.3.4[A] Hours of Operation A sign shall be posted stating the following:

1) The operating hours of the aquatic facility and
2) Unauthorized use of the aquatic facility outside of these hours is prohibited.

5.8.5.3 Safety Equipment Required at Facilities with Lifeguards

5.8.5.3.1[A] UV Protection for Chairs and Stands Lifeguards and lifeguard positions must be provided protection from UV radiation exposure.

5.8.5.3.2[A] Backboard At least one backboard constructed of material easily SANITIZED/disinfected shall be provided.

5.8.5.3.2.1 Backboard Number and Location The number and location of backboards shall be sufficient to affect a 2-minute response time to the location of the incident.

5.8.5.3.2.2 Backboard Components The backboard shall be equipped with a head immobilizer and sufficient straps to immobilize a person to the backboard.

5.8.5.3.3[A] Rescue Tube Immediately Available Each QUALIFIED LIFEGUARD conducting PATRON surveillance with the responsibility of in-water rescue in less than 3 feet (0.9 m) of water shall have a rescue tube immediately available for use.

5.8.5.3.4[A] Rescue Tube on Person Each QUALIFIED LIFEGUARD conducting PATRON surveillance in a water depth of 3 feet (0.9 m) or greater shall have a rescue tube on his/her person in a rescue ready position.

5.8.5.3.5[A] Identifying Uniform QUALIFIED LIFEGUARDS shall wear attire that readily identifies them as members of the AQUATIC FACILITY'S lifeguard staff. The word "Lifeguard" or "Guard" shall be prominently displayed on the outermost layer of a lifeguard's uniform.

5.8.5.3.6[A] Signal Device A whistle or other signaling device shall be worn by each QUALIFIED LIFEGUARD conducting PATRON surveillance for communicating to users and/or staff.

5.8.5.3.7[A] Sun Blocking Methods All AQUATIC FACILITIES where QUALIFIED LIFEGUARDS can be exposed to UV radiation shall train lifeguards about the use of protective clothing, hats, sun-blocking umbrellas, and sunscreen application and re-application using or exceeding SPF Level 15 to protect exposed skin areas including the associated risks of using/not using protective measures.

5.8.5.3.7.1 Lifeguards Responsible QUALIFIED LIFEGUARDS are responsible for protecting themselves from UV radiation exposure and wearing appropriate sunglasses and sunscreen.

5.8.5.3.8[A] Polarized Sunglasses When glare impacts the ability to see below the water's surface, QUALIFIED LIFEGUARDS shall wear polarized sunglasses while conducting BATHER surveillance.

5.8.5.3.9[A] Personal Protective Equipment Personal protective devices including a resuscitation mask with one-way valve and non-latex, non-powdered, one-use disposable gloves shall be worn in the form of a hip pack or attached to the rescue tube of all QUALIFIED LIFEGUARDS on-duty.

5.8.5.3.10[A] Rescue Throwing Device AQUATIC FACILITIES with one QUALIFIED LIFEGUARD shall provide and maintain a U.S. Coast Guard-approved aquatic rescue throwing device as per the specifications of MAHC 5.8.5.4.1.

5.8.5.3.11[A] Reaching Pole AQUATIC FACILITIES with one QUALIFIED LIFEGUARD shall provide and maintain a reaching pole as per the specifications of MAHC 5.8.5.4.2.

5.8.5.4 Safety Equipment and Signage Required at Facilities without Lifeguards

5.8.5.4.1[A] Throwing Device AQUATIC VENUES whose depth exceeds 2 feet (61.0 cm) of standing water shall provide and maintain a U.S. Coast Guard-approved aquatic rescue throwing device, with at least a quarter-inch (6.3 mm) thick rope whose length is 50 feet (15.2 m) or 1.5 times the width of the POOL, whichever is less.

5.8.5.4.1.1 Throwing Device Location The rescue throwing device shall be located in the immediate vicinity to the AQUATIC VENUE and be accessible to BATHERS.

5.8.5.4.2[A] Reaching Pole AQUATIC VENUES whose depth exceeds 2 feet (61 cm) of standing water shall provide and maintain a reaching pole of 12 feet (3.7 m)–16 feet (4.9 m) in length, non-telescopic, light in weight, and with a securely attached Shepherd's Crook with an aperture of at least 18 inches (45.7 cm).

5.8.5.4.2.1 Reaching Pole Location The reaching pole shall be located in the immediate vicinity to the AQUATIC VENUE and be accessible to BATHERS and PATRONS.

5.8.5.4.2.2 Non-Conductive Material Reaching poles provided by the AQUATIC FACILITY after the adoption date of this CODE shall be of non-conductive material.

5.8.5.4.3[A] CPR Posters CPR posters that are up to date with latest CPR programs and protocols shall be posted conspicuously at all times.

5.8.5.4.4[A] Imminent Health Hazard Sign A sign shall be posted outlining the IMMINENT HEALTH HAZARDS, which require AQUATIC VENUE or AQUATIC FACILITY closure as defined in this CODE per MAHC 6.6.3.1 and a telephone number to report problems to the owner/operator.

5.8.5.4.5[A] Additional Signage For any AQUATIC VENUE with standing water, a sign shall be posted signifying a QUALIFIED LIFEGUARD is not on duty and that the following rules apply:

1) Persons under the age of 14 years cannot be in the AQUATIC VENUE without direct supervision by a person aged 18 years or older; and
2) Youth and childcare groups, training, lifeguard courses, and swim lessons are not allowed without a QUALIFIED LIFEGUARD providing PATRON surveillance.

5.8.6 Enclosures and Barriers

5.8.6.1 General Requirements All required ENCLOSURES shall be maintained to prevent unauthorized entry to the protected space.

5.8.6.2 Construction Requirements (N/A)

5.8.6.3 Gates and Doors

5.8.6.3.1 Self-Closing and Latching All primary public access gates or doors serving as part of an ENCLOSURE shall have functional self-closing and self-latching closures unless the gate or door meets the exceptions in MAHC 4.8.6.3.1.6.1 or 4.8.6.3.1.6.2 and staff and QUALIFIED LIFEGUARDS are provided per MAHC 6.3.4.1 and 6.3.4.3.1.

5.8.6.3.1.1 Exception Gates or doors used solely for after-hours maintenance shall remain locked at all times when not in use by staff.

5.8.6.3.1.2 Propping Open Required self-closing and self-latching gates or doors serving as part of a guarded ENCLOSURE may be maintained in the open position when the AQUATIC VENUE is open and staffed as required.

5.9[A] Filter/Equipment Room and Chemical Room Storage

5.9.1 Equipment Room

5.9.1.1 Equipment Room The equipment room shall be maintained and operated so that the equipment room continues to meet all of its original design and construction requirements.

5.9.2 Chemical Storage

5.9.2.1[A] Code Compliance Chemical storage shall be in compliance with all applicable local, state, territorial, federal, and tribal laws.

5.9.2.2[A] OSHA and EPA Chemical handling shall be in compliance with OSHA and EPA regulations.

5.9.2.3[A] Safety Data Sheets For each chemical, STORAGE, handling, and use of the chemical shall be in compliance with the manufacturer's SDS and labels.

5.9.2.4 Access Prevention AQUATIC VENUE chemicals shall be stored to prevent access by unauthorized individuals.

5.9.2.5[A] Protected AQUATIC VENUE chemicals shall be stored so that they are protected from getting wet.

5.9.2.6[A] No Mixing AQUATIC VENUE chemicals shall be stored so that if the packages were to leak, no mixing of incompatible materials would occur.

5.9.2.6.1 Safety Data Sheets Consulted SDS shall be consulted for incompatibilities.

5.9.2.7[A] Ignition Sources Possible ignition sources, including but not limited to gasoline, diesel, natural gas, or gas-powered equipment such as lawn mowers, motors, grills, POOL heaters, or portable stoves shall not be stored or installed in the CHEMICAL STORAGE SPACE.

5.9.2.8 Smoking Smoking shall be prohibited in the CHEMICAL STORAGE SPACE.

5.9.2.9[A] Lighting Lighting shall be at minimum 30 footcandles (323 lux) to allow operators to read labels on containers throughout the CHEMICAL STORAGE SPACE and pump room.

5.9.2.10[A] Personal Protective Equipment PPE shall be available as indicated on the chemical SDSs.

5.9.2.11 Storage Chemicals shall be stored away from direct sunlight, temperature extremes, and high humidity.

5.9.2.12 Single Container A single container of a particular chemical that has been opened and that is currently in use in the pump room may be kept in a staging area of the pump room only if the chemical(s) will be protected from exposure to heat and moisture.

5.9.2.13 Separate The CHEMICAL STORAGE SPACE shall be separate from the equipment room.

5.9.2.13.1 Waiver For AQUATIC FACILITIES that do not currently have a CHEMICAL STORAGE SPACE separate from the EQUIPMENT ROOM, this requirement may be waived at the discretion of the local public health and/or fire officials if the chemicals are protected from exposure to heat and moisture and no IMMINENT HEALTH HAZARDS or SAFETY threats are identified.

5.9.2.14 Warning Signs Warning signs in compliance with NFPA or HMIS ratings shall be posted on CHEMICAL STORAGE SPACE doors.

5.9.3 Chemical Handling

5.9.3.1 Identity Containers of chemicals shall be labeled, tagged, or marked with the identity of the material and a statement of the hazardous effects of the chemical according to OSHA or EPA materials labeling requirements.

5.9.3.1.1 Labeling All AQUATIC VENUE chemical containers shall be labeled according to OSHA or EPA materials labeling requirements.

5.9.3.2 NSF Standard The chemical equipment used in controlling the quality of water shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization and used only in accordance with the manufacturer's instructions.

5.9.3.3 Measuring Devices Chemicals shall be measured using a dedicated measuring device where applicable.

5.9.3.3.1 Clean and Dry These measuring devices shall be clean, dry, and constructed of material compatible with the chemical to be measured to prevent the introduction of incompatible chemicals.

5.9.3.4 Chemical Addition Methods

5.9.3.4.1 Automatically Introduced DISINFECTION and pH control chemicals shall be automatically introduced through the RECIRCULATION SYSTEM.

5.9.3.4.1.1 Manual Addition SUPERCHLORINATION or shock chemicals and other POOL chemicals other than DISINFECTION and pH control may be added manually to the POOL.

5.9.3.4.1.2 Absence of Bathers Chemicals added manually directly into the AQUATIC VENUE shall only be introduced in the absence of BATHERS.

5.9.3.4.2 Safety Requirements Treatment chemicals shall be added in strict adherence to the manufacturer's use instructions to ensure concentrations in the water are safe for human exposure. Refer to MAHC 5.7.3.

5.9.3.4.2.1 Diluted Whenever required by the manufacturer, chemicals shall be diluted (or mixed with water) prior to application and as per the manufacturer's directions.

5.9.3.4.2.2 Added Chemicals shall be added to water when diluting as opposed to adding water to a concentrated chemical.

5.9.3.4.2.3 Mixed Each chemical shall be mixed in a separate, labeled container.

5.9.3.4.2.3.1 Never Mixed Together Two or more chemicals shall never be mixed in the same dilution water.

5.10 Hygiene Facilities

5.10.1 General [N/A]

5.10.2 Location [N/A]

5.10.3 Bathhouse Design [N/A]

5.10.4 Plumbing Fixture Requirements

5.10.4.1[A] General Requirements

5.10.4.1.1 Cleaned and Sanitized HYGIENE FACILITY FIXTURES, dressing area FIXTURES, and furniture shall be cleaned and SANITIZED daily with an EPA–REGISTERED product, and more often if necessary, to provide a clean and sanitary environment.

5.10.4.1.2 Mold and Mildew HYGIENE FACILITY floors, walls, and ceilings shall be kept clean and free of visible mold and mildew.

5.10.4.1.3 Hand Wash Station HANDWASHING STATIONS shall include the following items:

1) Hand wash sink,
2) Adjacent soap with dispenser,
3) Hand drying device or paper towels and dispenser, and
4) Trash receptacle.

5.10.4.2 Cleansing Showers

5.10.4.2.1 Cleaned and Sanitized CLEANSING SHOWERS shall be cleaned and SANITIZED daily with an EPA–REGISTERED product, and more often if necessary, to provide a clean and sanitary environment.

5.10.4.3[A] Rinse Showers

5.10.4.3.1 Cleaned RINSE SHOWERS shall be cleaned daily and more often if necessary with an EPA–REGISTERED product to provide a clean and sanitary environment.

5.10.4.3.2 Easy Access RINSE SHOWERS shall be easily accessible.

5.10.4.3.3 Not Blocked Equipment and furniture on the DECK shall not block access to RINSE SHOWERS.

5.10.4.3.4 No Soap Soap dispensers and soap shall be prohibited at RINSE SHOWERS.

5.10.4.4 All Showers [N/A]

5.10.4.5[A] Diaper-Changing Stations DIAPER-CHANGING STATIONS are required in all AQUATIC FACILITIES upon adoption of this CODE per MAHC 4.10.4.5.1.

5.10.4.5.1 Hand Wash Sink Installed and Operational The adjacent handwashing sink shall be installed and operational within 1 year from the date of the AHJ's adoption of the MAHC.

5.10.4.5.2 Cleaned DIAPER-CHANGING STATIONS shall be cleaned and disinfected daily and more often if necessary to provide a clean and sanitary environment.

5.10.4.5.2.1 Maintained They shall be maintained in good condition and free of visible contamination.

5.10.4.5.3 Disinfectant EPA–REGISTERED disinfectant shall be provided in the form of either of the following:

1) A solution in a spray dispenser with paper towels and dispenser, or
2) Wipes contained within a dispenser.

5.10.4.5.3.1 Covers If disposable DIAPER-CHANGING UNIT covers are provided in addition to disinfectant, they shall cover the DIAPER-CHANGING UNIT surface during use and keep the unit in clean condition.

5.10.4.5.4 Portable Handwashing Station If a portable HANDWASHING STATION is provided for use it shall be operational and maintained in good condition at all times.

5.10.4.6[A] Non-Plumbing Fixture Requirements

5.10.4.6.1 Paper Towels If paper towels are used for hand drying, a dispenser and paper towels shall be provided for use at HANDWASHING STATIONS.

5.10.4.6.2 Soap Soap dispensers shall be provided at HANDWASHING STATIONS and CLEANSING SHOWERS and shall be kept full of liquid or granular soap.

5.10.4.6.2.1 Bar Soap Bar soap shall be prohibited.

5.10.4.6.3 Trash A minimum of one hands-free trash receptacle shall be provided in areas adjacent to handwashing sinks.

5.10.4.6.3.1 Trash Emptying Trash receptacles shall be emptied daily and more often if necessary to provide a clean and sanitary environment.

5.10.4.6.4 Floor Coverings Non-permanent floor coverings (including but not limited to mats and racks) shall be removable and maintained in accordance with MAHC 5.10.4.1.1.

5.10.4.6.4.1 Wood Wooden racks, duckboards, and wooden mats shall be prohibited on HYGIENE FACILITY and dressing area flooring.

5.10.4.7 Sharps

5.10.4.7.1 Biohazard Action Plan A biohazard action plan shall also be on file as required by all applicable local, state, territorial, federal, and tribal laws and as part of the AQUATIC FACILITY SAFETY PLAN.

5.10.4.7.2 Disposed Sharps within approved containers shall be disposed of as needed by the AQUATIC FACILITY in accordance with all applicable local, state, territorial, federal, and tribal laws.

5.10.5 Provision of Suits, Towels, and Shared Equipment

5.10.5.1[A] Towels All towels provided by the AQUATIC FACILITY shall be washed with detergent in warm water, rinsed, and thoroughly dried at the warmest temperature listed on the fabric label after each use.

5.10.5.2 Suits Any attire provided by the AQUATIC FACILITY shall be washed in accordance with the fabric label or manufacturer's instructions.

5.10.5.3 Receptacles Non-absorbent, easily cleanable receptacles shall be provided for collection of used suits and towels.

5.10.5.4[A] Shared Equipment Cleaned and Sanitized Equipment provided by the AQUATIC FACILITY that comes into contact with BATHER'S eyes, nose, ears, and mouth (including but not limited to snorkels, nose clips, and goggles) shall be cleaned, SANITIZED between uses, and stored in a manner to prevent biological growth.

5.10.5.5[A] Other Equipment Other shared equipment provided by the AQUATIC FACILITY, including but not limited to fins, kickboards, tubes, lifejackets, and noodles, shall be kept clean and stored in a manner to prevent mold and other biological growth.

5.10.5.6 Good Repair Shared equipment shall be maintained in good repair.

5.10.5.7 Used Equipment Used and un-SANITIZED shared equipment shall be kept separate from cleaned and SANITIZED shared equipment.

5.10.5.7.1 Receptacles Non-absorbent, easily cleanable receptacles shall be provided for collection of used shared equipment.

5.11 Water Supply / Wastewater Disposal [N/A]

5.12 Special Requirements for Specific Aquatic Venues

5.12.1 Spas

5.12.1.1 Required Operation Time SPA filtration systems shall be operated 24 hours per day except for periods of draining, filling, and maintenance.

5.12.1.2[A] Drainage and Replacement SPAS shall be drained, cleaned, scrubbed, and water replaced as calculated in MAHC 5.12.1.2.1 or as needed to maintain water clarity and quality per MAHC.

5.12.1.2.1 Calculated The water replacement interval (in days) shall be calculated by dividing the SPA volume (in gallons) by 3 and then dividing by the average number of users per day or at a minimum of every 1–2 weeks.

5.12.1.3 Scrubbed SPA surfaces, including interior of SKIMMERS, shall be scrubbed or wiped down, and all water drained prior to refill.

5.12.2[A] Waterslides and Landing Pools

5.12.2.1 Signage Warning signs shall be posted in accordance with manufacturer's recommendations.

5.12.3 Wave Pools

5.12.3.1[A] Life Jackets U.S. Coast Guard-approved life jackets that are properly sized and fitted shall be provided free and shall be available at, or adjacent to, the AQUATIC VENUE.

5.12.4 Therapy Pools [N/A]

5.12.5 Lazy Rivers [N/A]

5.12.6 Moveable Floors

5.12.6.1 Starting Platforms The use of starting platforms in the area of a MOVEABLE FLOOR shall be prohibited when the water depth is shallower than the minimum required water depth of 4 feet (1.2 m). Use may only occur as per MAHC 5.6.10.3.

5.12.6.2 Diving Boards When a MOVEABLE FLOOR is installed into a DIVING POOL, diving shall be prohibited unless the DIVING POOL depth meets criteria set in MAHC 4.8.2.1.1.

5.12.7 Bulkheads

5.12.7.1 Open Area If a BULKHEAD is operated with an open area underneath, no one shall be allowed to swim beneath the BULKHEAD.

5.12.7.2 Bulkhead Travel The BULKHEAD position shall be maintained such that it cannot encroach on any required clearances of other features such as diving boards.

5.12.8 Interactive Water Play Aquatic Venues

5.12.8.1 Cracks CRACKS in the INTERACTIVE WATER PLAY AQUATIC VENUE shall be repaired when they may be a potential for leakage, present a tripping hazard, a potential cause of lacerations, or impact the ability to properly clean and maintain the INTERACTIVE WATER PLAY AQUATIC VENUE area.

5.12.8.2 Cleaning When cleaning the INTERACTIVE WATER PLAY AQUATIC VENUE CONTAMINANTS shall be removed or washed to the sanitary sewer.

5.12.8.2.1 No Sanitary Sewer Drain Available If no sanitary sewer drain is available then debris shall be washed/rinsed to the nearest DECK drain or removed in a manner that prevents CONTAMINANTS from reentering the INTERACTIVE WATER PLAY AQUATIC VENUE.

5.12.8.3 Water Quality Advisories NON-RECIRCULATED INTERACTIVE WATER PLAY AQUATIC VENUES shall be closed during Water Quality Advisories as issued by the AHJ and as per MAHC 6.6.3.1.

5.12.8.3.1 Prior To Reopening For Use The NON-RECIRCULATED INTERACTIVE WATER PLAY AQUATIC VENUE features shall be activated and flushed per the AHJ prior to reopening for use.

5.12.8.4 Regular Draining and Flushing Plumbing systems, including spray features, spray feature piping, and spray feature reservoirs, for interactive water play aquatic features shall be completely drained during non-operational times.

5.12.8.4.1 Flushed NON-RECIRCULATED plumbing shall be flushed out by running the approved water source immediately prior to opening for daily use by BATHERS.

5.12.9 Wading Pools [N/A]

5.12.10 Other Aquatic Venues [N/A]

6.0 Policies and Management

The provisions of Chapter 6 shall apply to all AQUATIC FACILITIES covered by this CODE regardless of when constructed, unless otherwise noted.

Note: Section numbers with superscript "A" (e.g., 6.0[A]) denote a corresponding discussion in the Annex to the Model Aquatic Health Code.

6.0.1[A] Staff Training All QUALIFIED OPERATORS, RESPONSIBLE SUPERVISORS, maintenance staff, QUALIFIED LIFEGUARD staff, or any others who are involved in the STORAGE, use, or handling of chemicals shall receive training prior to access of chemicals and receive at least an annual review of procedures thereafter for the following topics discussed in MAHC 6.0.1.1 to 6.0.1.5.

6.0.1.1 Storage and Handling Procedures for chemical storage and handling outlined in this CODE.

6.0.1.2 Personal Protective Equipment Procedures STANDARD precautions, PPE, and other measures to minimize exposure to chemicals as required by OSHA. This shall include staff training in PPE and respiratory protective devices when required.

6.0.1.3 Spill Procedures Spill Procedures and Emergency Response outlined in this CODE.

6.0.1.4 OSHA Requirements Federal OSHA Requirements Hazard Communication Standard (Employee Right-to-Know) and SDS. Know the location and availability of STANDARD and the written program.

6.0.1.5 Chemical and Safety Data Sheets Lists Know workplace chemicals list and SDS.

6.0.1.6 Training Plan Employers shall have a training plan in place and implement training for employees on chemicals used at the AQUATIC FACILITY before their first assignment and whenever a new hazard is introduced into the work area.

6.0.1.6.1[A] Training Topics The training shall include at a minimum:

1) How to recognize and avoid chemical hazards,
2) The physical and health hazards of chemicals used at the facility,
3) How to detect the presence or release of a hazardous chemical,
4) Required PPE necessary to avoid the hazards,
5) Use of PPE,
6) Chemical spill response, and
7) How to read and understand the chemical labels or other forms of warning including SDS sheets.

6.0.1.7 Training Records Records of all training shall be recorded and maintained on file.

6.0.1.8[A] Body Fluid Exposure Employees assigned to roles which have the potential for an occupational exposure to bloodborne pathogens, pathogens that cause RWIs, or other pathogens shall be trained to recognize and respond to body fluid (blood, feces, vomit) releases in and around the AQUATIC VENUE area.

6.0.1.9 Exposure Control Program Employers shall have an Exposure Control Program for bloodborne pathogens as required by OSHA 29 CFR 1910.1030.

6.0.1.10 Personal Protective Equipment Provided and Disposed PPE shall be provided and properly disposed.

6.1 Qualified Operator Training

6.1.1[A] Qualified Operator Qualifications and Certification

6.1.1.1 Qualifications A QUALIFIED OPERATOR of an AQUATIC FACILITY shall have completed an operator training course that is recognized by the AHJ.

6.1.1.2 Training Documentation A QUALIFIED OPERATOR shall have a current certificate or written documentation acceptable to the AHJ showing completion of an operator training course.

6.1.1.2.1 Certificate Available Originals or copies of such certificate or documentation shall be available onsite for inspection by the AHJ for each QUALIFIED OPERATOR employed at or contracted by the site, as specified in this CODE.

6.1.1.2.2 Originals Originals shall be made available upon request by the AHJ.

6.1.2[A] Essential Topics in Qualified Operator Training Courses

6.1.2.1 Course Content All operator training courses recognized by the AHJ shall include, at a minimum, the following teaching elements:

1) Water disinfection,
2) Water chemistry,
3) Mechanical systems, and
4) Health and SAFETY operations.

6.1.2.1.1[A] Water Disinfection Water DISINFECTION including:

1) Water disinfection,
2) CT or Concentration X Time values,
3) Chlorine,
4) CYA,
5) Bromine,
6) Breakpoint,
7) Superchlorination,
8) Hyperchlorination,
9) Combined chlorine,
10) Secondary treatment, and
11) Supplemental treatment.

6.1.2.1.1.1 Disinfectants Disinfectant types including:

1) Descriptions of different types of disinfectants,
2) Their unique physical (e.g., shape or state [solid, liquid, or gas]) and chemical properties (e.g., how it reacts with acids or bases),
3) How they disinfect and impact water chemistry and MONITORING systems,
4) How to calculate dosing,
5) How they are used safely, and

6) The advantages or disadvantages of using each disinfectant.

6.1.2.1.1.2 CT Inactivation Values CT or Concentration x Time values including:

1) How to calculate the amount of time needed to inactivate PATHOGENS at a given concentration of a disinfectant, and
2) The importance and reasons for maintaining appropriate water pH and temperature.

6.1.2.1.1.3 Bromine Bromine including:

1) Definition of bromine as an element,
2) Its use as a residual disinfectant and oxidizer in water,
3) Bromine chemistry,
4) The DISINFECTION role of HOBr,
5) Onsite generation,
6) pH meter requirements to prevent false readings, and
7) Bromine reuse.

6.1.2.1.1.4 Chlorine CHLORINE including:

1) Definition of CHLORINE as an element,
2) Its use as a residual disinfectant and oxidizer in water,
3) CHLORINE chemistry and the role of pH,
4) The DISINFECTION role of HOCl,
5) Unstabilized products (sodium hypochlorite, calcium hypochlorite, lithium hypochlorite, and CHLORINE gas),
6) Stabilized products (sodium dichloro-s-triazinetrione and trichloro-s-triazinetrione),
7) Safe chemical handling, and
8) Onsite CHLORINE generation.

6.1.2.1.1.5 Cyanuric Acid CYA and stabilized CHLORINE product use including:

1) Description of CYA and how CHLORINE is bound to it,
2) Description of CYA use via addition of stabilized CHLORINE compounds or addition of CYA alone,
3) Response curves showing the impact of CYA on stabilization of FREE CHLORINE RESIDUALS in the presence of UV,
4) Dose response curves showing the impact of CYA on CHLORINE kill rates including the impact of CYA concentrations on diarrheal fecal incident remediation procedures,
5) Strategies for controlling the concentration of CYA,
6) Strategies for reducing the concentration of CYA when it exceeds the maximum allowable concentration, and
7) Response curves showing the impact of CYA on HOCl concentrations.

6.1.2.1.1.6 Breakpoint Chlorination Breakpoint chlorination including how to achieve it through calculation of chemical dosing to reach the desired DPD-FC concentration and its relationship to reducing

and controlling formation of combined chlorine including guidance for how to perform breakpoint chlorination in indoor aquatic facilities.

6.1.2.1.1.7 Hyperchlorination HYPERCHLORINATION includes procedures for implementing a CONTAMINATION RESPONSE PLAN for fecal/vomit/blood.

6.1.2.1.1.8 Combined Chlorine Combined chlorine including:

1) How different COMBINED CHLORINE and DBPS are formed in the water and air;
2) The maximum acceptable concentration of COMBINED CHLORINE;
3) How methods such as water replacement, BREAKPOINT CHLORINATION, UV light, ozone, ventilation, and use of other oxidizers can reduce COMBINED CHLORINE concentration;
4) The advantages and disadvantages of each; and
5) Possible health effects of COMBINED CHLORINE products in the air, particularly in INDOOR AQUATIC FACILITIES.

6.1.2.1.1.9 Secondary Disinfection SECONDARY TREATMENT including:

1) How ozone and UV disinfectants are used in conjunction with residual disinfectants to inactivate pathogens and
2) Sizing guidelines/dosing calculations, safe use, and advantages and disadvantages of each method.

6.1.2.1.1.10 Supplemental Treatment SUPPLEMENTAL TREATMENT includes other DISINFECTION chemicals or systems on the market and their effectiveness in water treatment.

6.1.2.1.2 Water Chemistry Course work for water chemistry shall include:

1) Source water,
2) Water balance,
3) Saturation index,
4) Water clarity,
5) pH,
6) Total alkalinity,
7) Calcium hardness,
8) Water temperature,
9) Total dissolved solids,
10) Water treatment systems, and
11) Water testing.

6.1.2.1.2.1 Source Water Source water including requirements for supply and pre-treatment.

6.1.2.1.2.2 Water Balance Water balance including:

1) Effect of unbalanced water on DISINFECTION, AQUATIC FEATURE surfaces, mechanical equipment, and FIXTURES; and
2) Details of water balance including pH, total alkalinity, calcium hardness, temperature, and TDS.

6.1.2.1.2.3 Saturation Index SATURATION INDEX including calculations, ideal values, and effects of values which are too low or too high.

6.1.2.1.2.4 Water Clarity Water clarity including:

1) Reasons why water quality is so important,
2) Causes of poor water clarity,
3) Maintenance of good water clarity, and
4) Closure requirements when water clarity is poor.

6.1.2.1.2.5 pH pH including:

1) How pH is a measure of the concentration of hydrogen ions in water,
2) Effects of high and low pH on BATHERS and equipment,
3) Ideal pH range for BATHER and equipment,
4) Factors that affect pH,
5) How pH affects disinfectant efficacy, and
6) How to decrease and increase pH.

6.1.2.1.2.6 Total Alkalinity Total alkalinity including:

1) How total alkalinity relates to pH,
2) Effects of low and high total alkalinity,
3) Factors that affect total alkalinity,
4) Ideal total alkalinity range, and
5) How to increase or decrease total alkalinity.

6.1.2.1.2.7 Calcium Hardness Calcium hardness including:

1) Why water naturally contains calcium,
2) How calcium hardness relates to total hardness and temperature,
3) Effects of low and high calcium hardness,
4) Factors that affect calcium hardness,
5) Ideal calcium hardness range, and
6) How to increase or decrease calcium hardness.

6.1.2.1.2.8 Temperature Water temperature including:

1) How low and high water temperatures increase the likelihood of corrosion and scaling, respectively;
2) Effect on DISINFECTION, its health effects, and other operational considerations;
3) Health effects; and
4) Other operational considerations.

6.1.2.1.2.9 Total Dissolved Solids TDS including:

1) Why the concentration of TDS increases over time,
2) Association with conductivity and organic CONTAMINANTS, and
3) Key TDS concentrations as they relate to starting up an AQUATIC FACILITY and galvanic corrosion.

6.1.2.1.2.10 Water Treatment Systems Water treatment systems including:

1) Descriptions of system use, MONITORING, calibration, and maintenance of automatic controllers;
2) Descriptions of common types of liquid, dry chemical, and gas mechanical feeders;
3) CHLORINE, bromine, and ozone generators;
4) UV light systems;
5) Unique features of feeders, generators, and systems;
6) How to generally operate and maintain them;
7) Advantages and disadvantages of different feeders, UV light systems, and ozonator types; and
8) Alternate treatment methods.

6.1.2.1.2.11 Water Testing Water testing including:

1) How different methods (including but not limited to colorimetric, titrimetric, turbidimetric, and electronic) test water to determine the following values:
    a) DPD-FC and TOTAL AVAILABLE CHLORINE,
    b) TOTAL BROMINE,
    c) pH,
    d) Total alkalinity,
    e) Calcium hardness,
    f) Temperature,
    g) TDS,
    h) CYA,
    i) Metals, and
    j) Any other tests (including but not limited to salt concentrations, phosphates, nitrates, potassium monopersulfate, copper, iron, and bacterial testing);
2) The advantages and disadvantages of each method;
3) How to maintain testing equipment;
4) How to collect water samples;
5) How to perform and interpret tests;
6) How frequently to test;
7) The steps of the dilution method; and
8) How to calculate COMBINED CHLORINE concentrations.

6.1.2.1.3 Mechanical Systems Course work for mechanical systems shall include:

1) Calculations,
2) Circulation,
3) Main drains,
4) Gutters and surface SKIMMERS,
5) Mechanical system balance,

6) Circulation pump and motor,
7) Valve,
8) Return INLETS,
9) Filtration, and
10) Filter backwashing/cleaning.

6.1.2.1.3.1 Maintenance Calculations Calculations including:

1) Explanations of why particular calculations are important;
2) How to convert units of measurement within and between the English and metric systems;
3) How to determine the surface area of regularly and irregularly shape AQUATIC VENUES;
4) How to determine the water volume of regularly and irregularly shaped AQUATIC VENUES; and
5) Why proper sizing of filters, pumps, pipes, and feeders is important.

6.1.2.1.3.2 Circulation Circulation including:

1) Why circulation is needed;
2) Factors that affect water flow;
3) How direct suction and overflow systems work;
4) How to calculate TURNOVER and flow rates;
5) How the following components of the circulation system relate to each other:
    a) Main drains,
    b) Gutters and surface SKIMMERS,
    c) Circulation pump and motor,
    d) Surge tanks,
    e) Vacuum ports,
    f) Valves, and
    g) Return INLETS;
6) How to read flow meters;
7) How to safely operate pressurized systems after the pump;
8) Information on dye testing;
9) An understanding of TDH;
10) How it TDH calculated;
11) How TDH is field-determined using vacuum and pressure gauges;
12) TDH effect on pump flow; and
13) Cross-connections.

6.1.2.1.3.3 Main Drains Main drains including:

1) A description of the role of main drains,
2) Why they should not be resized without engineering and public health consultation,

3) The importance of daily inspection of structural integrity, and
4) Discussion on balancing the need to maximize surface water flow while minimizing the likelihood of entrapment.

6.1.2.1.3.4 Gutters & Surface Skimmers Gutters and surface SKIMMERS including:

1) Why it is important to collect surface water,
2) A description of different gutter types (at a minimum: scum, surge, and rim-flow),
3) How each type generally works,
4) The advantages and disadvantages of each, and
5) Description of the components of SKIMMERS (e.g., weir, basket, and equalizer assembly) and their respective roles.

6.1.2.1.3.5 Mechanical System Balance Mechanical system balance including:

1) An understanding of mechanical system balancing,
2) Methodology for setting proper operational water levels,
3) Basic hydraulics which affect proper functioning of the balance tank and AQUATIC VENUE,
4) Methods of setting and adjusting modulation valves,
5) Balance lines,
6) SKIMMERS,
7) Main drains,
8) The operation of the water make-up system,
9) Collector tanks/gravity drainage systems, and
10) Automatic controllers.

6.1.2.1.3.6 Circulation Pump & Motor Circulation pump and motor including:

1) Descriptions of the role of the pump and motor,
2) Self-priming and flooded suction pumps,
3) Key components of a pump and how they work together,
4) Cavitation,
5) Possible causes of cavitation, and
6) Troubleshooting problems with the pump and motor.

6.1.2.1.3.7 Valves Valves including descriptions of different types of valves (e.g., gate, ball, butterfly/wafer, multi-port, globe, modulating / automatic, and check) and their safe operation.

6.1.2.1.3.8 Return Inlets Return INLETS including a description of the role of return INLETS and the importance of replacing fittings with those that meet original specifications.

6.1.2.1.3.9 Filtration Filtration including:

1) Why filtration is needed;
2) A description of pressure and vacuum filters and different types of filter media;
3) How to calculate filter surface area;

4) How to read pressure gauges;
5) A general description of sand, cartridge, and diatomaceous earth filters and alternative filter media types to include, at a minimum, perlite, zeolite, and crushed glass;
6) The characteristic flow rates and particle size entrapment of each filter type;
7) How to generally operate and maintain each filter type;
8) Troubleshooting problems with the filter; and
9) The advantages and disadvantages of different filters and filter media.

6.1.2.1.3.10 Filter Backwashing/Cleaning Filter backwashing/cleaning including:

1) Determining and setting proper backwash flow rates,
2) When backwashing/cleaning should be done and the steps needed for clearing a filter of fine particles and other CONTAMINANTS,
3) Proper disposal of wastewater from backwash, and
4) What additional FIXTURES/equipment may be needed (i.e., sump, separation tank).

6.1.2.1.4[A] Health and Safety Course work for health and SAFETY shall include:

1) Recreational water illness,
2) RWI prevention,
3) Risk management,
4) Record keeping,
5) Chemical SAFETY,
6) Entrapment prevention,
7) Electrical SAFETY,
8) Rescue equipment,
9) Injury prevention,
10) Drowning prevention,
11) BARRIERS and ENCLOSURES,
12) Signage and depth markers,
13) Facility sanitation,
14) Emergency response, and
15) Surveillance and supervision.

6.1.2.1.4.1[A] Recreational Water Illness Recreational water illness (RWI) including:

1) How water can contain or become contaminated with parasites, bacteria, viruses, fungi, DBPS, or unsafe concentrations of chemicals and
2) The role of the operator in reducing risk.

6.1.2.1.4.2 Causes of RWIs Common infectious and chemical causes of RWIs, including but not limited to:

1) Diarrheal illness (*Cryptosporidium*, *Giardia*, *Shigella*, and norovirus),

2) Skin rashes (*Pseudomonas aeruginosa*, molluscum contagiosum virus),
3) Respiratory illness (*Legionella*),
4) Neurologic infections (echovirus, *Naegleria*),
5) Eye/ear illness (Pseudomonas aeruginosa, adenovirus, Acanthamoeba),
6) Hypersensitivity reactions (Mycobacterium avium complex, Pontiac fever, endotoxins), and
7) Health effects of chloramines and DBPS.

6.1.2.1.4.3[A] RWI Prevention Recreational water illness (RWI) prevention including:

1) Methods of prevention of RWIs, including but not limited to chemical concentration control;
2) Why public health, operators, and PATRONS need to be educated about RWIs and collaborate on RWI prevention;
3) The role of showering;
4) The efficacy of swim diapers;
5) Formed-stool and diarrheal fecal incident response; and
6) Developing a plan to minimize pathogen and other biological (e.g., blood, vomit, sweat, urine, and skin and hair care products) contamination of the water.

6.1.2.1.4.4 Risk Management Risk management including techniques that identify hazards and risks and that prevent illness and injuries associated with AQUATIC FACILITIES open to the public.

6.1.2.1.4.5 Record Keeping Record keeping including the need to keep accurate and timely records of the following areas:

1) Operational conditions (e.g., water chemistry, water temperature, filter pressure differential, flow meter reading, and water clarity),
2) Maintenance performed (e.g., backwashing, change of equipment),
3) Incidents and response (e.g., fecal incidents in the water and injuries), and
4) Staff training and attendance.

6.1.2.1.4.6[A] Chemical Safety Chemical SAFETY including steps to safely store and handle chemicals including:

1) How to read labels and SDS,
2) How to prevent individual chemicals and inorganic and organic CHLORINE products from mixing together or with other substances (including water) or in chemical feeders, and
3) Use of PPE.

6.1.2.1.4.7[A] Entrapment Prevention Entrapment prevention including:

1) Different types of entrapment (e.g., hair, limb, body, evisceration/disembowelment, and mechanical),
2) How to prevent and/or decrease likelihood of entrapment, and
3) Requirements of the VGB Act.

6.1.2.1.4.8 Electrical Safety Electrical SAFETY including possible causes of electrical shock and steps that can be taken to prevent electrical shock (e.g., bonding, grounding, GROUND-FAULT CIRCUIT INTERRUPTERS, and prevention of accidental immersion of electrical devices).

6.1.2.1.4.9 Rescue Equipment Rescue equipment including a description and rationale for the most commonly found rescue equipment including:

1) Rescue tubes,
2) Reaching poles,
3) Ring buoys and throwing lines,
4) Backboards,
5) First aid kits,
6) Emergency alert systems,
7) Emergency phones with current numbers posted, and
8) Resuscitation equipment.

6.1.2.1.4.10 Injury Prevention Injury prevention including basic steps known to decrease the likelihood of injury, at a minimum:

1) Banning glass containers at AQUATIC FACILITIES,
2) PATRON education, and
3) Daily visual inspection for hazards.

6.1.2.1.4.11 Drowning Prevention Drowning prevention including causes and prevention of drowning.

6.1.2.1.4.12 Enclosures ENCLOSURES including descriptions of how fences, gates, doors, and safety covers can be used to prevent access to water; and basics of design that effectively prevent access to water.

6.1.2.1.4.13 Signage & Depth Markers Signage and depth markers including the importance of maintaining signage and depth markers.

6.1.2.1.4.14 Facility Sanitation Facility sanitation including:

1) Steps to clean and disinfect all surfaces that PATRONS would commonly come in contact with (e.g., DECK, restrooms, and DIAPER-CHANGING STATIONS) and
2) Procedures for implementation of MAHC 6.5: Fecal-Vomit-Blood Contamination Response, in relation to responding to a body fluid spill on these surfaces.

6.1.2.1.4.15 Emergency Response Plan Emergency response plan including:

1) Steps to respond to emergencies (at a minimum, severe weather events, drowning or injury, contamination of the water, chemical incidents) and
2) Communication and coordination with emergency responders and local health department notification as part of an EAP.

6.1.2.1.5[A] Operations Course work for operations shall include:

1) Regulations;
2) The role of local, state, territorial, and tribal health departments;
3) Aquatic facility types;
4) Daily/routine operations;
5) Preventive maintenance;
6) Weatherizing;

7) AQUATIC FACILITY renovation and design;
8) Heating;
9) Air circulation; and
10) Spa and therapy pool issues.

6.1.2.1.5.1 Regulations Regulations including applicable local, state, territorial, federal, and tribal laws and STANDARDS relating to the operation of AQUATIC FACILITIES.

6.1.2.1.5.1.1 Immediate Closure Course work shall also highlight reasons why an inspector or operator would immediately close an AQUATIC FACILITY.

6.1.2.1.5.2 Health Departments Duties and responsibilities of local, state, territorial, and tribal health departments including stressing the importance of a good working relationship with the health department.

6.1.2.1.5.3 Aquatic Facility Types AQUATIC FACILITY types including common AQUATIC VENUE types and settings and a discussion of features and play equipment that require specific operation and maintenance steps.

6.1.2.1.5.4[A] Daily/Routine Operations Daily/routine operations including listing and describing the daily inspection and maintenance requirements of an AQUATIC FACILITY including, but not limited to items listed:

1) Walkways/DECK and exits are clear, clean, free of debris;
2) Drain covers, vacuum fitting covers, SKIMMER equalizer covers, and any other suction outlet covers are in place, secure, and unbroken;
3) SKIMMER baskets, weirs, lids, flow adjusters, and suction outlets are free of any blockage;
4) INLET and return covers and any other fittings are in place, secure, and unbroken;
5) Safety warning signs and other signage are in place and in good repair;
6) Entrapment prevention systems are operational;
7) Recirculation, DISINFECTION systems, controller(s), and probes are operating as required;
8) SECONDARY TREATMENT or SUPPLEMENTAL TREATMENT systems are operating as required;
9) Underwater lights and other lighting are intact with no exposed wires or water in lights;
10) Slime and biofilm have been removed from accessible surfaces of AQUATIC VENUE, SLIDES, and other AQUATIC FEATURES;
11) Doors to nonpublic areas (CHEMICAL STORAGE SPACES, offices, etc.) are locked;
12) First aid supplies are stocked;
13) Emergency communication equipment and systems are operational;
14) Fecal/vomit/blood incident CONTAMINATION RESPONSE PLANS, materials, and equipment are available;
15) AQUATIC FEATURES and amenities are functioning in accordance with the manufacturer's recommendations;
16) Fencing/ENCLOSURES, gates, and self-latching or other locks are tested and are intact and functioning properly, and ENCLOSURES do not have nearby furniture to encourage climbing;
17) Drinking fountains are clean and in functional condition;

18) Electrical devices are in good working condition and meet the requirements specified in the MAHC;

19) Alarms, if required, are tested and functioning properly;

20) Assessing glare conditions throughout operating hours to assess whether the bottom and objects in the POOL are clearly visible;

21) Play structures and diving boards are in good condition;

22) Safety equipment as required by this CODE is in good condition, properly secured, accessible for intended use, and shall include at a minimum:

    a) Emergency instructions and phone numbers,

    b) Rescue tubes,

    c) Resuscitation masks with one-way valve,

    d) First aid kits,

    e) AEDs,

    f) BVMs,

    g) Backboard, head immobilizer, straps, and

    h) Lifeguard stands;

23) Emergency shutoff systems (SLIDES, water features, pumps, etc.) function properly;

24) Depth markings are clearly visible;

25) Lifelines and buoys are in place and in good working order;

26) Ladders are SLIP RESISTANT and rungs secured tightly;

27) WATERSLIDES are in functional, safe condition;

28) Moveable fulcrum is adjusted properly to control spring in the board as necessary;

29) Moveable starting platforms are properly stored;

30) Access to permanent starting platforms is restricted or controlled when not in use by swim teams and prohibited when not in use by competitive swimming or swimming practice that is under direct supervision of an instructor or coach;

31) Railings are secure;

32) SVRS is functioning according to manufacturer's guidelines;

33) SKIMMER baskets and covers are clean and in place;

34) Water quality and clarity is MAHC compliant;

35) Water level is appropriate;

36) Pumps retain the appropriate pressure;

37) Play structures are secure (consider water velocity and reference manufacturers recommended levels);

38) Verify required documentation and records are in place and signed by the appropriate personnel; and

39) Soap dispensers in lavatories and SHOWERS are functional and supplied with soap.

6.1.2.1.5.5 Preventive Maintenance Preventive maintenance including how to develop:

1) A preventive maintenance plan,
2) Routine maintenance procedures, and
3) Record keeping system needed to track maintenance performed.

6.1.2.1.5.6 Weatherizing Weatherizing including the importance of weatherizing and the steps to prevent damage to AQUATIC FACILITIES and their mechanical systems due to very low temperatures or extreme weather conditions (e.g., flooding).

6.1.2.1.5.7 Facility Renovation & Design AQUATIC FACILITY renovation and design including:

1) Definitions of AQUATIC FACILITY renovation, remodeling, and SUBSTANTIAL ALTERATION;
2) When it is necessary to renovate;
3) When it is necessary to notify the AHJ of planned renovations and remodeling; and
4) Current trends in facility renovation and design.

6.1.2.1.5.8 Heating Heating issues including:

1) Recommended water temperatures and limits,
2) Factors that contribute to the water's heat loss and gain,
3) Heating equipment options,
4) Sizing gas heaters, and
5) How to troubleshoot problems with heaters.

6.1.2.1.5.9 Air Circulation Air circulation including:

1) Air handling system considerations for an indoor aquatic facility,
2) The importance of regulating humidity,
3) The need to maintain negative pressure,
4) How poor indoor air quality can affect PATRONS and staff, and
5) How to balance air change and energy efficiency.

6.1.2.1.5.10 Spa & Therapy Pool Issues SPA and THERAPY POOL issues including:

1) Operational implications of smaller volumes of water and HOT WATER;
2) How to maintain water chemistry;
3) Typical water temperature ranges highlighting maximum temperatures;
4) Risks of hyperthermia and hypothermia;
5) Need for emergency shut-off switches; and
6) Frequency of cleaning, draining, and DISINFECTION.

6.1.3 General Requirements for Operator Training Courses

6.1.3.1 Course Providers

6.1.3.1.1 Recognized Courses Providers of recognized operator training courses, if required by the AHJ to verify that the course meets the requirements and intent of this CODE, shall submit course information including:

1) Course development expertise,
2) Course content,
3) Course length,
4) Instructor qualifications,
5) Exam administration,
6) Certificate procedures, and
7) Updates of information as changes are made.

6.1.3.1.2 Providers Operator training courses shall be developed by individuals or organizations with expertise in AQUATIC FACILITY operation and maintenance and expertise in education or training as evidenced by combined work experience and training.

6.1.3.2 Course Content Training materials at a minimum, covering all of the essential topics as outlined in MAHC 6.1.2.1 shall be provided and used in operator training courses.

6.1.3.3[A] Course Length Course agenda or syllabus shall show time planned for each essential topic.

6.1.3.4[A] Instructor Requirements Operator training course providers shall furnish course instructor information including:

1) Expertise in AQUATIC FACILITY operation and maintenance, as evidenced by work experience and/or training;
2) Completion of an operator training course, which at a minimum, covers all of the essential topics as outlined in MAHC 6.1.2.1, including passing the final exam,
3) Successful completion of an operator training instructor course, and
4) If the operator training course is online, procedures which make such an instructor available to answer students' questions during normal business hours.

6.1.3.5[A] Final Exam Operator training course providers shall furnish course final exam information including:

1) Final exam(s), which at a minimum, covers all of the essential topics as outlined in MAHC 6.1.2.1,
2) Final exam passing score criteria, and
3) Final exam security procedures.

6.1.3.5.1 Final Exam Administration Operator training course providers shall provide final exam administration, proctoring and security procedures including:

1) Checking student's government-issued photo identification, or another established process, to ensure that the individual taking the exam is the same person who is given a certificate documenting course completion and passing of exam;
2) Final exam completion is without assistance or aids that are not allowed by the training agency; and
3) Final exam is passed, prior to issuance of a QUALIFIED OPERATOR certificate.

6.1.3.6[A] Course Certificates Operator training course providers shall furnish course certificate information including:

1) Procedures for issuing nontransferable certificates to the individuals who successfully complete the course work and pass the final exam,

2) Procedures for delivery of course certificates to the individuals who successfully complete the course work and pass the final exam,

3) Instructions for the participant to maintain their originally issued certificate, or a copy thereof, for the duration of its validity, and

4) Procedures for the operator training course provider to maintain an individual's training and exam record for a minimum period of 5 years after the expiration of the individual's certificate.

6.1.3.7[A] Continuing Education [N/A]

6.1.3.8[A] Certificate Renewal Operator training course providers shall furnish course certificate renewal information including:

1) Criteria for re-examination with a renewal exam that meets the specifications for initial exam requirements and certificate issuance specified in this CODE or

2) Criteria for a refresher course with an exam that meets the specifications for the initial course, exam, and certificate issuance requirements specified in this CODE.

6.1.3.9[A] Certificate Suspension and Revocation Course providers shall have procedures in place for the suspension or revocation of certificates.

6.1.3.9.1 Evidence of Health Hazard Course providers may suspend or revoke a QUALIFIED OPERATOR'S certificate based on evidence that the QUALIFIED OPERATOR'S actions or inactions unduly created SAFETY and health hazards.

6.1.3.9.2 Evidence of Cheating Course providers may suspend or revoke a QUALIFIED OPERATOR'S certificate based on evidence of cheating or obtaining the certificate under false pretenses.

6.1.3.10[A] Additional Training or Testing The AHJ may, at its discretion, require additional operator training or testing.

6.1.3.11[A] Certificate Recognition The AHJ may, at its discretion, choose to recognize, not to recognize, or rescind a previously recognized certificate of a QUALIFIED OPERATOR based upon demonstration of inadequate knowledge, poor performance, or due cause.

6.1.3.12[A] Course Recognition The AHJ may, at its discretion, recognize, choose not to recognize, or revoke a previously accepted course based upon demonstration of inadequate knowledge or poor performance of its QUALIFIED OPERATORS, or due cause.

6.1.3.13[A] Length of Certificate Validity The maximum length of validity for QUALIFIED OPERATOR training certificate shall be 5 years.

6.2[A] Lifeguard Training

6.2.1[A] Lifeguard Qualifications A qualified lifeguard shall:

1) Have successfully completed an AHJ-recognized lifeguard training course offered by an AHJ-recognized training agency,

2) Possess a current certificate for such training,

3) Have met all pre-service requirements, and

4) Participate in continuing in-service training requirements of the AQUATIC FACILITY.

6.2.1.1[A] Course Content Lifeguard Training Courses shall include but not be limited to:

1) Hazard identification and injury prevention,

2) Emergencies,
3) CPR,
4) AED use,
5) BVM (adult & pediatric) use,
6) Benefits of emergency oxygen administration for drowning emergencies,
7) First aid, and
8) Legal issues.

6.2.1.1.1[A] Hazard Identification and Injury Prevention Hazard identification and injury prevention shall include:

1) Identification of common hazards or causes of injuries and their prevention,
2) Responsibilities of a QUALIFIED LIFEGUARD in prevention strategies,
3) Victim recognition,
4) Victim recognition scanning strategies,
5) Factors which impede victim recognition,
6) Health and SAFETY issues related to lifeguarding, and
7) Prevention of voluntary hyperventilation and extended breath holding activities.

6.2.1.1.2[A] Emergency Response Skill Set Emergency response content shall include:

1) Responsibilities of a QUALIFIED LIFEGUARD in reacting to an emergency;
2) Recognition and identification of a person in distress and/or drowning;
3) Methods to communicate in response to an emergency;
4) Rescue skills for a person who is responsive or unresponsive, in distress, or drowning;
5) Skills required to rescue a person to a position of safety;
6) Skills required to extricate a person from the water with assistance from another lifeguard(s) and/or PATRON(S); and
7) Knowledge of the typical components of an EAP for AQUATIC VENUES.

6.2.1.1.3[A] Resuscitation Skills CPR/AED, AED use, BVM (adult & pediatric) use, and other resuscitation skills shall be professional level skills that follow treatment protocols consistent with the current ECC and/or; the ILCOR guidelines for cardiac compressions; foreign body restriction removal; and rescue breathing for infants, children, and adults.

6.2.1.1.4 First Aid First aid training shall include:

1) Basic treatment of bleeding, shock, sudden illness, and muscular/skeletal injuries;
2) Knowing when and how to activate the EMS;
3) Rescue and emergency care skills to minimize movement of the head, neck and spine until EMS arrives for a person who has suffered a suspected spinal injury on land or in the water; and
4) Use and the importance of universal precautions and PPE in dealing with body fluids, blood, and preventing contamination according to current OSHA guidelines.

6.2.1.1.5[A] Legal Issues Course content related to legal issues shall include but not be limited to:

1) Duty to act,
2) STANDARD of care,
3) Negligence,
4) Consent,
5) Refusal of care,
6) Abandonment,
7) Confidentiality, and
8) Documentation.

6.2.1.2 Lifeguard Training Delivery

6.2.1.2.1[A] Standardized and Comprehensive The educational delivery system shall include standardized student and instructor materials to convey all topics including but not limited to those listed per MAHC 6.2.1.1.

6.2.1.2.2[A] Skills Practice Physical training of lifeguarding skills shall include in-water and out-of- water skill practices led by an individual currently certified as an instructor by the training agency which developed the lifeguard course materials.

6.2.1.2.3[A] Shallow Water Training If a training agency offers a certification with a distinction between "shallow water" and "deep water" lifeguards, candidates for shallow water certification shall have training and evaluation in the deepest depth allowed for the certification.

6.2.1.2.4[A] Deep Water Training If a training agency offers a certification with a distinction between "shallow water" and "deep water" lifeguards, candidates for deep water certification shall have training and evaluation in at least the minimum depth allowed for the certification.

6.2.1.2.5[A] Sufficient Time Course length shall provide sufficient time to cover content, practice, skills, and evaluate competency for the topics listed in MAHC 6.2.1.1.

6.2.1.2.6[A] Certified Instructors Lifeguard instructor courses shall be taught only by individuals currently certified as instructor trainers by the training agency which developed the lifeguard course materials.

6.2.1.2.6.1[A] Minimum Prerequisites Lifeguard training agencies shall develop minimum instructor prerequisites that include, but are not limited to, those outlined in MAHC 6.2.1.2.6.2.

6.2.1.2.6.2[A] Completed Training Prior to instructing lifeguard training, instructors are required to have successfully completed a lifeguard training course which complies with MAHC 6.2.1.1 and a lifeguard instructor training course which includes, at a minimum, the following:

1) Mastery and knowledge of lifeguard training course content,
2) Demonstration of the ability to effectively deliver lifeguard training course content,
3) An evaluation and feedback process to improve instructor candidate presentation skills/techniques,
4) Course management and administration procedures, and
5) Testing and evaluation procedures.

6.2.1.2.6.3[A] Instructor Renewal/Recertification Process Lifeguard training agencies shall have a lifeguard instructor renewal/recertification process.

6.2.1.2.6.4[A] Quality Control Training agencies shall have a quality control system in place for evaluating a lifeguard instructor's ability to conduct courses.

6.2.1.2.7[A] Training Equipment All lifeguard training courses shall have, at a minimum, the following pieces of equipment available in appropriate student to equipment ratios during the course:

1) Rescue tubes,
2) Backboard with head immobilizer and sufficient straps to immobilize the victim to the backboard,
3) CPR manikins (Adult and infant),
4) Resuscitation mask with one-way valve,
5) BVM (Adult and Pediatric),
6) Disposable gloves,
7) AED trainer with adult and pediatric training pads,
8) First aid supplies for first aid training, and
9) Manikin cleaning supplies.

6.2.1.3 Competency and Certification

6.2.1.3.1 Proficiency Lifeguarding skills per MAHC 6.2.1.1 shall be tested, by a certified instructor, to a level of proficiency accepted by the training agency.

6.2.1.3.2[A] Requirements Lifeguard training course providers shall have a final exam including but not limited to:

1) Written and practical exams covering topics outlined in MAHC 6.2.1.1;
2) Final exam passing score criteria, including the level of proficiency needed to pass practical and written exams; and
3) Security procedures for proctoring the final exam to include:
    a) Checking student's government-issued photo identification, or another established process, to ensure that the individual taking the exam is the same person who is given a certificate documenting course completion and passing of exam; and
    b) Final exam is passed, prior to issuance of a certificate.

6.2.1.3.3[A] Instructor Physically Present The instructor of record shall be physically present at all classroom and in-person contact time, skills evaluation, and testing during the course.

6.2.1.3.4[A] Certifications Lifeguard and lifeguard instructor certifications shall be issued to recognize successful completion of the course as per the requirements of MAHC 6.2.1.1 through 6.2.1.3.8.

6.2.1.3.5[A] Number of Years Length of valid certification shall be a maximum of 2 years for lifeguarding and first aid, and a maximum of 1 year for Cardiopulmonary Resuscitation (CPR/AED).

6.2.1.3.6[A] Documentation Course documentation of training and certificates shall identify the following:

1) Name of trainee,
2) Level of training,
3) Expiration date,
4) Restrictions on depth of water for which the lifeguard is qualified,
5) Identifier of the instructor of record,
6) Any other restrictions that maybe applied by the training agency, and

7) Identifier of the agency providing the certification.

6.2.1.3.7[A] Expired Certificate When a certificate has expired for more than 45 days, the QUALIFIED LIFEGUARD shall retake the course.

6.2.1.3.7.1 Expired Less than 45 Days When a certificate has expired for 45 days or less, the QUALIFIED LIFEGUARD shall retake the course or complete a challenge program.

6.2.1.3.7.2[A] Challenge Program A QUALIFIED LIFEGUARD challenge program, when utilized, shall be completed in accordance with the training of the original certifying agency, by an instructor certified by the original certifying agency, and include but not be limited to:

1) Pre-requisite screening;
2) A final practical exam, with certified instructor present, demonstrating all skills, in and out of the water required in the original lifeguard course for certification, which complies with MAHC 6.2.1.1, and uses the equipment specified in MAHC 6.2.1.2.7; and
3) Final written, proctored exam.

6.2.1.3.7.3[A] Certificate Renewal Certificate renewal, when used, shall include the following:

1) Completion no later than 45 days after certificate expiration;
2) Conducted in accordance with the training of the original certifying agency;
3) Taught by an instructor certified by the original certifying agency;
4) Conducted with a demonstration of skills, in and out of the water, required in the original course, which complies with MAHC 6.2.1.1, and uses the equipment specified in MAHC 6.2.1.2.7;
5) A final written, proctored exam; and
6) A final practical exam with a certified instructor(s) of record present and actively administering the practical testing; or
7) Completion of a Challenge Program in accordance with MAHC 6.2.1.3.7.2, no later than 45 days after certificate expiration.

6.2.1.3.8[A] Certificate Suspension and Revocation Lifeguard training agencies shall have procedures in place for the suspension or revocation of certificates.

6.2.2 Lifeguard Supervisor Training

6.2.2.1[A] Lifeguard Supervisor Qualifications A LIFEGUARD SUPERVISOR shall have:

1) A current certificate for lifeguard training from an AHJ-recognized agency,
2) A current certificate for LIFEGUARD SUPERVISOR training from an AHJ-recognized agency
3) Previous experience as a QUALIFIED LIFEGUARD of at least 100 hours of active duty, and
4) Ability to effectively communicate in English or languages common with safety team members and emergency services.

6.2.2.2[A] Lifeguard Supervisor Training Elements LIFEGUARD SUPERVISOR training shall include, at a minimum, the following:

1) Activation and execution of EAPS,
2) CPR/AED and first aid training that complies with MAHC 6.2.1.1.3 and 6.2.1.1.4 or present an unexpired certificate issued by an AHJ-approved agency documenting the required training has been completed,

3) Scanning and vigilance requirements and how to ensure that systems which accomplish these goals are in place and operational,

4) Development and evaluation of zones of BATHER surveillance responsibility diagrams for an AQUATIC VENUE,

5) MONITORING lifeguard performance as it relates to lifeguard and facility-specific training, including pre- service assessments,

6) Strategies to reduce risk and mitigate the health and SAFETY hazards to both the PATRONS and the staff,

7) Knowledge of the legal issues and responsibilities relating to lifeguarding as listed in MAHC 6.2.1.1.5, and

8) Knowledge of the proper use and maintenance of the equipment required per MAHC 5.8.5.

6.2.2.3 Lifeguard Supervisor Training Delivery

6.2.2.3.1[A] Standardized and Comprehensive

6.2.2.3.1.1 Traditional and Blended Courses For traditional and blended learning courses, the educational delivery system shall include standardized student and instructor content and delivery to convey all topics including but not limited to those listed per MAHC 6.2.2.2.

6.2.2.3.1.2 E-Learning Courses For e-learning courses, the educational delivery system shall include defined learning objectives, and standardized student content and delivery to convey all topics including but not limited to those listed per MAHC 6.2.2.2.

6.2.2.3.2[A] Sufficient Time

6.2.2.3.2.1 Traditional and Blended Courses For traditional and blended learning classes, course length shall provide sufficient time to cover content, demonstration, skill practice, and evaluate competency for the topics listed in MAHC 6.2.2.2.

6.2.2.3.2.2 E-Learning Courses For e-learning courses, course length shall provide sufficient time to cover content, provide for online activities relating to content as necessary to reinforce comprehension of learning objectives, and assessments sufficient to evaluate competency for the topics listed in MAHC 6.2.2.2.

6.2.2.3.3 Course Setting LIFEGUARD SUPERVISOR training courses shall be:

1) Taught in person by a trained LIFEGUARD SUPERVISOR instructor,

2) Blended learning offerings with electronic content deliverables created, and presented by, and in-person portions taught by, trained LIFEGUARD SUPERVISOR instructors, or

3) Online offerings created and presented by trained LIFEGUARD SUPERVISOR instructors.

6.2.2.3.4[A] Lifeguard Supervisor Course Instructor Certification LIFEGUARD SUPERVISOR course instructors shall be certified through a training agency or by the facility whose training programs meets the requirements specified in MAHC 6.2.2.

6.2.2.3.4.1 Lifeguard Supervisor Course Instructor LIFEGUARD SUPERVISOR course shall be taught by trained LIFEGUARD SUPERVISOR instructors through a training agency or by the facility whose training programs meets the requirements specified in MAHC 6.2.2.

6.2.2.3.4.2[A] Minimum Prerequisites Course providers shall develop minimum instructor prerequisites that include, but are not limited to:

1) Successful completion of a lifeguard training course in the past;

2) Successful completion of a LIFEGUARD SUPERVISOR training course that complies with MAHC 6.2.2.2;

3) Ability to effectively communicate in English;

4) Has completed a LIFEGUARD SUPERVISOR instructor training course which includes, at a minimum, the following:

   a) Mastery and knowledge of LIFEGUARD SUPERVISOR training course content,

   b) Demonstration of the ability to effectively deliver LIFEGUARD SUPERVISOR training course content,

   c) An evaluation and feedback process to improve instructor candidate presentation skills/techniques,

   d) Course management and administration procedures, and

   e) Testing and evaluation procedures.

6.2.2.3.4.3[A] Quality Control Course provider shall have a quality control system in place for evaluating a LIFEGUARD SUPERVISOR instructor's ability to conduct courses.

6.2.2.3.4.4 Lifeguard Supervisor Renewal & Recertification LIFEGUARD SUPERVISOR training agencies shall have a LIFEGUARD SUPERVISOR instructor renewal/recertification process.

6.2.2.4 Competency and Certificate of Completion

6.2.2.4.1[A] Lifeguard Supervisor Proficiency LIFEGUARD SUPERVISOR training course providers shall have a method to evaluate proficiency of the content in MAHC 6.2.2.2.

6.2.2.4.2[A] Lifeguard Supervisor Certificate of Completion LIFEGUARD SUPERVISOR certificates of completion shall be issued by the course provider to recognize successful completion of the course as per the requirements of MAHC 6.2.2.2.

6.2.2.4.3 Number of Years Length of valid certification shall be a maximum of 2 years.

6.3 Facility Staffing

6.3.1 Qualified Operator Requirements and Availability

6.3.1.1 Onsite Qualified Operator Requirements

6.3.1.1.1 At Adoption The following MAHC sections shall be required for all AQUATIC FACILITIES at time of adoption:

1) MAHC 6.3.1.1: Onsite QUALIFIED OPERATORS and

2) MAHC 6.3.1.2: Contracted Off-Site QUALIFIED OPERATORS.

6.3.1.1.2 Size and Use A QUALIFIED OPERATOR shall be onsite or immediately available within 2 hours during all hours of operation at an AQUATIC FACILITY that has:

1) More than two AQUATIC VENUES,

2) An AQUATIC VENUE of over 50,000 gallons (189,270 L) of water,

3) AQUATIC VENUES that include AQUATIC FEATURES with recirculated water,

4) An AQUATIC VENUE used as a therapy pool, or

5) An AQUATIC VENUE used to provide swimming training.

6.3.1.1.3 Bathers and Management A QUALIFIED OPERATOR shall be onsite or immediately available within 2 hours during all hours of operation at an AQUATIC FACILITY that is:

1) Permitted BATHER COUNT is greater than 200 BATHERS daily,
2) Operated by a municipality, or
3) Operated by a school.

6.3.1.1.4 Compliance History A QUALIFIED OPERATOR shall be available onsite or immediately available within 2 hours during all hours of operation at an AQUATIC FACILITY that has a history of CODE violations which in the opinion of the operating permit-issuing official require one or more onsite QUALIFIED OPERATORS.

6.3.1.2 Contracted Off-site Qualified Operators All other AQUATIC FACILITIES shall have an onsite QUALIFIED OPERATOR immediately available within 2 hours or a contract with a QUALIFIED OPERATOR for a minimum of weekly visits and assistance whenever needed.

6.3.1.2.1 Visit Documentation Written documentation of these visits for contracted off-site QUALIFIED OPERATOR visits and assistance consultations shall be available at the AQUATIC FACILITY for review by the AHJ.

6.3.1.2.2 Documentation Details The written documentation shall indicate the checking, MONITORING, and testing outlined in MAHC 6.4.1.2.

6.3.1.2.3 Visit Corrective Actions The written documentation shall indicate what corrective actions, if any, were taken by the contracted off-site QUALIFIED OPERATOR during the scheduled visits or assistance requests.

6.3.1.2.4 Onsite Responsible Supervisor All AQUATIC FACILITIES without a full time onsite QUALIFIED OPERATOR shall have a designated onsite RESPONSIBLE SUPERVISOR.

6.3.1.2.5[A] Onsite Responsible Supervisor Duties The designated onsite RESPONSIBLE SUPERVISOR shall:

1) Be capable of testing and recording the water quality parameters required by this CODE,
2) Know how to make adjustments, as needed, to maintain required water quality parameters required by this CODE,
3) Know general maintenance procedures as required by daily operational verifications or adjustments required by this CODE,
4) Know when the AQUATIC FACILITY or individual AQUATIC VENUE should be closed, and
5) Know how and when to contact the contracted off-site QUALIFIED OPERATOR.

6.3.2 Aquatic Facilities Requiring Qualified Lifeguards AQUATIC VENUES with standing water and with any of the following conditions listed in MAHC 6.3.2.1 shall be required to have a lifeguard(s) sufficient to meet the requirements of MAHC section 6.3.3.1 conducting PATRON surveillance at all times the AQUATIC VENUE is open.

6.3.2.1[A] List of Aquatic Facilities Requiring Qualified Lifeguards Note: This list includes but shall not be limited to the following:

1) For new construction occurring from the date of acceptance of this CODE, any AQUATIC VENUE deeper than 5 feet (1.5 m) at any point;
2) Any AQUATIC VENUE that allows for unsupervised children under the age of 14 years;

3) Any AQUATIC VENUE while it is being used for the recreation of youth groups, including but not limited to childcare usage or school groups;
4) Any AQUATIC VENUE while it is being used for group training must have dedicated lifeguards on DECK for class surveillance, sufficient to meet the requirements of MAHC 6.3.3.1, including but not limited to competitive swimming and/or sports, lifeguard training, exercise programs, and swimming lessons;
5) Any AQUATIC VENUE with a configuration in which any point on the AQUATIC VENUE surface exceeds 30 feet (9.1 m) from the nearest DECK;
6) Any AQUATIC VENUE with an induced current or wave action including but not limited to WAVE POOLS and LAZY RIVERS;
7) Waterslide landing pools;
8) Any AQUATIC VENUE in which BATHERS enter the water from any height above the DECK including but not limited to diving boards, DROP SLIDES, starting platforms, and/or climbing walls. This includes POOL SLIDES that discharge into water depths deeper than 5 feet (1.5 m); and
9) Any AQUATIC FACILITY that sells or serves alcohol within the AQUATIC VENUE ENCLOSURE, during the periods when alcohol is sold or served.

6.3.3[A] Safety Plan All AQUATIC FACILITIES shall create and implement a SAFETY PLAN to include, but not be limited to the following elements:

1) Staffing plan,
2) EAP,
3) Biohazard action plan,
4) Pre-service training plan, and
5) In-service training plan.

6.3.3.1[A] Code Compliance Staff Plan Staffing plans shall designate person(s) as members of the SAFETY TEAM and person(s) for the following responsibilities:

1) Identifying and communicating health and SAFETY hazards;
2) Mitigating health and SAFETY hazards and closing the facility, if needed;
3) Interfacing with the AHJ related to the requirements of this CODE;
4) Maintaining water quality and, if required, air quality;
5) Enforcing the AQUATIC FACILITY rules and regulations;
6) Responding to reported emergencies;
7) Supervising the SAFETY TEAM;
8) Conducting pre-service evaluations; and
9) Conducting in-service training.

6.3.3.1.1[A] Zone of Patron Surveillance When QUALIFIED LIFEGUARDS are used, the staffing plan shall include diagrammed zones of PATRON surveillance for each AQUATIC VENUE such that:

1) The QUALIFIED LIFEGUARD is capable of viewing the entire area of the assigned zone of PATRON surveillance;

2) The QUALIFIED LIFEGUARD is able to reach the furthest extent of the assigned zone of PATRON surveillance within 20 seconds;

3) Identify whether the QUALIFIED LIFEGUARD is in an elevated stand, walking, in-water and/or other approved position;

4) Identifying any additional responsibilities for each zone; and

5) All areas of each AQUATIC VENUE are assigned a zone of PATRON surveillance.

6.3.3.1.2[A] Rotation Procedures When QUALIFIED LIFEGUARDS are used, the staffing plan shall include QUALIFIED LIFEGUARD rotation procedures such that:

1) Identifying all zones of PATRON surveillance responsibility at the AQUATIC FACILITY,

2) Operating in a manner so as to provide an alternation of tasks such that no QUALIFIED LIFEGUARD conducts PATRON surveillance activities for more than 60 continuous minutes, and

3) Have a practice of maintaining coverage of the zone of PATRON surveillance during the change of the QUALIFIED LIFEGUARD.

6.3.3.1.3 Alternation of Tasks Alternation of tasks may include any one of the following:

1) Change of zone of PATRON surveillance where the QUALIFIED LIFEGUARD must walk or be transported to another zone of PATRON surveillance.

2) Have a period of at least 10 minutes of non-PATRON surveillance activity such as taking a break, conducting maintenance, or conducting ride dispatch.

6.3.3.1.4 Supervision Protocols When QUALIFIED LIFEGUARDS are used, the staffing plan shall include lifeguard supervision protocols to achieve the requirements of MAHC 6.3.3.

6.3.3.2[A] Emergency Action Plan EAPS and operating procedures shall include but not be limited to:

1) Outline types of emergencies and IMMINENT HEALTH HAZARDS, as per MAHC 6.6.3;

2) Outline the methods of communication between responders, emergency services, and PATRONS;

3) Identify each anticipated responder;

4) Outline the tasks of each responder;

5) Identify required equipment for each task; and

6) Emergency closure requirements.

6.3.3.2.1[A] Coordination of Response When QUALIFIED LIFEGUARDS are used, the SAFETY PLAN and the EAP shall identify additional persons to respond and provide patient care as needed.

6.3.3.3 Pre-Service Requirements The Pre-Service Plan shall include:

1) Policies and procedure training specific to the AQUATIC FACILITY,

2) Demonstration of SAFETY TEAM skills specific to the AQUATIC FACILITY prior to assuming on-duty lifeguard responsibilities, and

3) Documentation of training.

6.3.3.3.1[A] Safety Team EAP Training Prior to active duty, all members of the SAFETY TEAM shall be trained on, and receive a copy of, and/or have a copy posted and always available of the specific policies and procedures for the following:

1) Staffing plan;

2) EAP;

3) Emergency closure; and

4) Fecal, vomit, or blood contamination on surfaces and in the water as outlined in MAHC 6.5.

6.3.3.3.2[A] Safety Team Skills Proficiency Prior to active duty, all members of the SAFETY TEAM shall demonstrate knowledge and skill competency specific to the AQUATIC FACILITY for the following criteria:

1) Understand their responsibilities and of others on the AQUATIC FACILITY SAFETY TEAM,

2) Ability to execute the EAP,

3) Know what conditions require closure of the facility, and

4) Know what actions to take in response to a fecal, vomit, or blood contamination on a surface and in the water as outlined in MAHC 6.5.

6.3.3.3.3[A] Qualified Lifeguard Emergency Action Plan Training When QUALIFIED LIFEGUARDS are used, they shall be trained on the EAP and receive a copy of or have a copy of the EAP posted and always available at the AQUATIC FACILITY, specifically including policies and procedures for the following:

1) Zone of PATRON surveillance plan,

2) Rotation plan,

3) Minimum staffing plan, and

4) Rescue / first aid response plan.

6.3.3.3.4[A] Qualified Lifeguard Skills Proficiency When QUALIFIED LIFEGUARDS are used, they shall demonstrate knowledge and skill competency specific to the AQUATIC FACILITY for the following criteria:

1) Ability to reach the bottom at the maximum water depth of the AQUATIC VENUE to be assigned;

2) Ability to identify all zones of BATHER surveillance responsibility to which they could be assigned;

3) Ability to recognize a victim in their assigned zone of BATHER surveillance;

4) Ability to reach the furthest edge of assigned zones of BATHER surveillance within 20 seconds;

5) Water rescue skills outlined in MAHC 6.2.1.1.2;

6) CPR/AED and first aid;

7) Ability to execute EAP;

8) Emergency closure issues; and

9) Fecal, vomit, or blood contamination incident response as outlined in MAHC 6.5.

6.3.3.3.5 CPR / AED and First Aid Certificate The designated person(s) with CPR/AED and first aid training shall present unexpired certificate(s) as per MAHC 6.2.1.1.3 and 6.2.1.1.4 prior to active duty.

6.3.3.3.5.1 Copies Maintained Originals or copies of certificates shall be maintained at the AQUATIC FACILITY and be available for inspection.

6.3.3.3.6[A] Documentation of Pre-Service Training Documentation verifying the pre-service requirements shall be completed by the person conducting the pre-service training, maintained at the facility for 3 full years, and be available for inspection.

6.3.3.3.6.1 Lifeguard Certificate When QUALIFIED LIFEGUARDS are used, they shall present an unexpired certificate as per MAHC 6.2.1.3.4 prior to assuming on-duty lifeguard responsibilities.

6.3.3.3.6.2 Copies Maintained Originals or copies of certificates shall be maintained at the facility and be available for inspection.

6.3.3.4 In-Service Training During the course of their employment, AQUATIC FACILITY staff shall participate in periodic in-service training to maintain their skills.

6.3.3.4.1[A] Documentation of In-Service Training Documentation verifying the in-service requirements shall be completed by the person conducting the in-service training, maintained at the AQUATIC FACILITY for 3 years, and available for inspection.

6.3.3.4.2[A] In-Service Documentation Documentation shall include:

1) Names of attendees,
2) Content of training,
3) Date of training, and
4) Name of the trainer(s).

6.3.3.4.3[A] In-Service Training Plan The in-service training plan shall include:

1) In-service training frequency,
2) Documentation of in-service training,
3) Maintenance of certifications, and
4) Demonstration of test-ready skills.

6.3.3.4.4 Maintain Certificates The designated person(s) with CPR/AED and first aid training shall maintain certifications to show the following:

1) CPR/AED training is completed annually and certificates are unexpired, and
2) First aid training certificates are unexpired.

6.3.3.4.5[A] Competency Demonstration When QUALIFIED LIFEGUARDS are used, they shall be able to demonstrate proficiency in the skills as outlined by MAHC 6.2.1 and have the ability to perform the following water rescue skills consecutively so as to demonstrate the ability to respond to victim and complete the rescue:

1) Reach the furthest edge of zones of BATHER surveillance within 20 seconds;
2) Recover a simulated victim, including extrication to a position of safety consistent with MAHC 6.2.1.1.2; and
3) Perform resuscitation skills consistent with MAHC 6.2.1.1.3.

6.3.3.5[A] AHJ Authority to Approve Safety Plan The AHJ shall have the authority, if they so choose, to require:

1) Submittal of the SAFETY PLAN for archiving and reference or
2) Submittal of the SAFETY PLAN for review and approval prior to opening to the public.

6.3.3.5.1[A] Safety Plan on File The SAFETY PLAN shall be kept on file at the AQUATIC FACILITY.

6.3.3.5.2[A] Safety Plan Implemented The elements detailed in the SAFETY PLAN shall be implemented and in evidence in the AQUATIC FACILITY operation and is subject to review for compliance by the AHJ at any time.

6.3.4 Staff Management

6.3.4.1 Staff Provided Prior to Aquatic Venue Use Prior to use of any AQUATIC VENUE, the AQUATIC FACILITY shall provide staff required per the provisions of the SAFETY PLAN as stated in MAHC 6.3.2.

6.3.4.2 Safety Team Responsibilities SAFETY TEAM responsibilities shall include but not be limited to:

1) Enforce the AQUATIC FACILITY rules and regulations by interfacing with PATRONS,
2) Respond to reported emergencies,
3) Identify health and SAFETY hazards and take action to mitigate or avoid the hazard,
4) Know where PPE is located and use it when required, and
5) Interface with the AHJ related to the requirements of this CODE.

6.3.4.3 Lifeguard Staff

6.3.4.3.1[A] Minimum Number of Lifeguards Where QUALIFIED LIFEGUARDS are used, the AQUATIC FACILITY shall provide, prior to opening the AQUATIC FACILITY to the public, the minimum number of QUALIFIED LIFEGUARDS and staff required per the provisions of the SAFETY PLAN such that:

1) An AQUATIC FACILITY having a single zone of patron surveillance shall have a minimum of two (2) QUALIFIED LIFEGUARDS present and available to respond to aquatic emergencies.
2) All zones of PATRON surveillance are staffed during operation;
    a) Zones of PATRON surveillance for individual AQUATIC VENUES not open for use, must also be staffed unless an effective means is provided to restrict and MONITOR access to the AQUATIC VENUE;
3) Rotations can be conducted while all zones are staffed;
4) LIFEGUARD SUPERVISOR, where required by MAHC 6.3.4.4.1, is present; and
5) Additional person(s) to rapidly respond to an emergency to help the initial rescuer, as required in MAHC 6.3.3.2.1, are present.

6.3.4.3.2[A] Lifeguard Responsibilities QUALIFIED LIFEGUARD responsibilities shall include but not be limited to:

1) MONITOR PATRONS within the zone of PATRON surveillance responsibility;
2) Enforce facility rules;
3) Respond to emergencies including water rescue, CPR, AED use if equipment is provided with established local protocols, and first aid;
4) Identify health and SAFETY hazards and take action to mitigate or avoid the hazard;
5) Maintain skills at a test-ready level of proficiency;
6) Wear the identifying uniform;
7) If needed for effective PATRON surveillance, wear corrective eyewear as necessary to correct poor vision and wear polarized sunglasses;
8) If exposed to UV, wear SPF 15 or greater UV protection; and
9) Know where PPE is located and use it when required.

6.3.4.3.3[A] Shallow Water Certified Lifeguards QUALIFIED LIFEGUARDS certified for shallow water depths shall not be assigned to a BODY OF WATER in which any part of the water's depth is greater than the depth for which they are certified.

6.3.4.3.4[A] Direct Surveillance QUALIFIED LIFEGUARDS assigned responsibilities for PATRON surveillance shall not be assigned other tasks that intrude on PATRON surveillance while performing those surveillance activities.

6.3.4.3.5[A] Distractions While conducting BATHER surveillance, QUALIFIED LIFEGUARDS shall not engage in social conversations or have on their person or lifeguard station, reading materials, cellular telephones, texting devices, music players, or other similar non-emergency electronic devices.

6.3.4.4 Supervisor Staff

6.3.4.4.1[A] Lifeguard Supervisor Required AQUATIC FACILITIES that are required to have two or more QUALIFIED LIFEGUARDS to satisfy Zone responsibilities per the Zone Plan of BATHER Surveillance in MAHC 6.3.3.1.1, shall have an additional person at the AQUATIC FACILITY during all hours of operation designated as the LIFEGUARD SUPERVISOR who meets the requirement of MAHC 6.2.2.

6.3.4.4.2[A] Designated Supervisor A person qualified as both a LIFEGUARD SUPERVISOR and QUALIFIED LIFEGUARD may be assigned both roles in an AQUATIC FACILITY Staffing Plan. If so, LIFEGUARD SUPERVISOR responsibilities must not interfere with PATRON surveillance when the person is assigned that task as a QUALIFIED LIFEGUARD.

6.3.4.4.2.1 Lifeguard Supervisor Duties

LIFEGUARD SUPERVISOR duties shall not interfere with the primary duty of PATRON surveillance.

6.3.4.4.3 Lifeguard Supervisor LIFEGUARD SUPERVISOR responsibilities shall include but not be limited to:

1) MONITOR performance of QUALIFIED LIFEGUARDS in their zone of BATHER surveillance responsibility,
2) Make sure the rotation is conducted in accordance with the SAFETY PLAN,
3) Coordinate staff response and BATHER care during an emergency,
4) Identify health and SAFETY hazards and communicate to staff and management to mitigate or otherwise avoid the hazard, and
5) Make sure the required equipment per MAHC 5.8.5 is in place and in good condition.

6.3.4.5 Emergency Response and Communications Plans

6.3.4.5.1[A] Emergency Response and Communication Plan AQUATIC FACILITIES shall create and maintain an operating procedure manual containing information on the emergency response and communications plan including an EAP, Facility Evacuation Plan, and Inclement Weather Plan.

6.3.4.5.2 Emergency Action Plan A written EAP shall be developed, maintained, and updated as necessary for the AQUATIC FACILITY.

6.3.4.5.3 Annual Review and Update The EAP shall be reviewed with the AQUATIC FACILITY staff and management annually or more frequently as required when changes occur with the dates of the review recorded in the EAP.

6.3.4.5.4 Available for Inspection The written EAP shall be kept at the AQUATIC FACILITY and available for emergency personnel and/or AHJ upon request.

6.3.4.5.5[A] Training Documentation Documentation from employees trained in current EAP shall be available upon request.

6.3.4.5.6 Components The EAP shall include at a minimum:

1) A diagram of the AQUATIC FACILITY;
2) A list of emergency telephone numbers;
3) The location of first aid kit and other rescue equipment (BVM, AED, if provided, backboard, etc.);
4) An emergency response plan for accidental chemical release; and
5) A fecal/vomit/blood CONTAMINATION RESPONSE PLANS as outlined in MAHC 6.5.1.

6.3.4.5.6.1 Accidental Chemical Release Plan The accidental chemical release plan shall include procedures for:

1) How to determine when professional hazardous materials (HAZMAT) response is needed,
2) How to obtain it,
3) Response and cleanup,
4) Provision for training staff in these procedures, and
5) A list of equipment and supplies for cleanup.

6.3.4.5.6.2 Remediation Supplies The availability of equipment and supplies for remediation procedures shall be verified by the operator at least weekly.

6.3.4.5.7 Facility Evacuation Plan A written Facility Evacuation Plan shall be developed and maintained for the facility.

6.3.4.5.7.1 Evacuation Plan Components This plan shall include at a minimum:

1) Actions to be taken in cases of drowning, serious illness or injury, chemical handling accidents, weather emergencies, and other serious incidents; and
2) Defined roles and responsibilities for all staff.

6.3.4.5.8[A] Communication Plan A communication plan shall exist to facilitate activation of internal emergency response centers and/or community 911/EMS as necessary.

6.3.4.5.8.1 Communication Plan Components At a minimum, this plan shall include:

1) Provision and use of readily accessible, appropriate communication devices such as telephones, call boxes, and mobile devices;
2) Signage;
3) Procedures to be followed during staffed and unstaffed time periods;
4) Acceptable alternative communication during loss of power; and
5) Training of all personnel.

6.3.4.5.8.2[A] Notification Procedures The communication plan shall include a plan for notification to federal or tribal; state or territorial; and local agencies in case of a chemical spill that exceeds the EPA reportable quantity.

6.3.4.5.9[A] Inclement Weather Plan AQUATIC FACILITIES shall have a contingency/response plan for localized weather events that may affect their operation (i.e., lightning, hurricanes, tornados, high winds, etc.).

6.3.4.5.9.1 Contingency Plan Contingency plans shall include training for employees, evacuation procedures, and determining when it is acceptable to reopen a facility for operation.

6.3.4.6[A] Remote Monitoring Systems

6.3.4.6.1[A] Lifeguard-Based Lifeguard-based remote SAFETY MONITORING systems shall not replace the need for QUALIFIED LIFEGUARDS.

6.3.4.6.1.1 No Substitute Remote SAFETY MONITORING systems may be used to aid the operation but not as a substitute for QUALIFIED LIFEGUARDS/SLIDE operators when critical areas such as blind spots in an AQUATIC VENUE or area of a SLIDE cannot be viewed by QUALIFIED LIFEGUARDS/SLIDE operators.

6.3.4.6.2[A] Operator-Based QUALIFIED OPERATOR-based remote water quality MONITORING systems shall not be a substitute for manual water quality testing of the AQUATIC VENUE.

6.3.4.6.3 Training When QUALIFIED LIFEGUARD- or QUALIFIED OPERATOR-based remote MONITORING systems are used, AQUATIC FACILITY staff shall be trained on their use, limitations, and communication and response protocols for communications with the MONITORING group.

6.3.4.7[A] Employee Illness and Injury Policy

6.3.4.7.1 Illness Policy Supervisors shall not permit employees who are ill with diarrhea to enter the water or perform in a QUALIFIED LIFEGUARD role.

6.3.4.7.2 Open Wounds Supervisors shall permit employees with open wounds in the water or in a QUALIFIED LIFEGUARD role only if they have healthcare provider approval or wear a waterproof, occlusive bandage to cover the wound.

6.4[A] Aquatic Facility Management

6.4.1 Operations

6.4.1.1 Operations Manual

6.4.1.1.1[A] Develop Each AQUATIC FACILITY shall develop an operations manual to keep at the AQUATIC FACILITY in both printed and electronic formats.

6.4.1.1.2[A] Include The manual shall at minimum include, but not be limited to the following items:

1) AQUATIC VENUE and AQUATIC FEATURE description(s) and locations,
2) Facility communication,
3) List of chemicals and system information,
4) Fecal/vomit/blood CONTAMINATION RESPONSE PLANS,
5) Preventive maintenance plan, and
6) Any other STANDARD operation and maintenance policies and instructions or applicable information for each AQUATIC VENUE and AQUATIC FEATURE at the facility.

6.4.1.2 Operation Records AQUATIC FACILITIES shall keep records pertaining to the operation, maintenance, and management of the AQUATIC FACILITY on a minimum schedule as prescribed under MAHC 6.4.1.2.

6.4.1.2.1 Record Maintenance AQUATIC FACILITY records shall be:

1) Kept for a minimum of 3 years and
2) Available upon request by the AHJ.

6.4.1.2.2 Additional Documentation Applicable local, state, territorial, federal, or tribal laws may require additional records, documentation, and forms.

6.4.1.3 Safety and Maintenance Inspection and Recordkeeping The QUALIFIED OPERATOR or RESPONSIBLE SUPERVISOR shall ensure that SAFETY and preventive maintenance inspections are done at the AQUATIC FACILITY during seasons or periods when the AQUATIC FACILITY is open and that the results are recorded in a log or form maintained at the AQUATIC FACILITY.

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:

1) Walkways/DECK and exits are clear, clean, free of debris;
2) Drain covers, vacuum fitting covers, SKIMMER equalizer covers, and any other suction outlet covers are in place, secure, and unbroken;
3) SKIMMER baskets, weirs, lids, flow adjusters, and suction outlets are free of any blockage;
4) INLET and return covers and any other fittings are in place, secure, and unbroken;
5) Safety warning signs and other signage are in place and in good repair;
6) Safety equipment as required by this CODE are in place and in good repair, including emergency instructions and phone numbers;
7) Entrapment prevention systems are operational;
8) Recirculation, DISINFECTION systems, controller(s), and probes are operating as required;
9) SECONDARY TREATMENT and/or SUPPLEMENTAL TREATMENT systems are operating as required;
10) Underwater lights and other lighting are intact with no exposed wires or water in lights;
11) Slime and biofilm have been removed from accessible surfaces of AQUATIC VENUES, SLIDES, and other AQUATIC FEATURES;
12) Doors to nonpublic areas (CHEMICAL STORAGE SPACES, offices, etc.) are locked;
13) First aid supplies are stocked;
14) Emergency communication equipment and systems are operational;
15) Fecal/vomit/blood incident CONTAMINATION RESPONSE PLANS, materials, and equipment are available;
16) Water features and amenities are functioning in accordance with the manufacturer's recommendations;
17) Fencing/ENCLOSURES, gates, and self-latching or other locks are tested and are intact and functioning properly, and ENCLOSURES do not have nearby furniture to encourage climbing;
18) Drinking fountains are clean and in functional condition;
19) Electrical devices are in good working condition and meet the requirements specified in the MAHC;
20) Alarms, if required, are tested and functioning properly; and
21) Assessing water clarity such that the bottom and objects in the POOL are clearly visible.

6.4.1.3.2 Other Inspection Items The QUALIFIED OPERATOR or RESPONSIBLE SUPERVISOR shall ensure that the AQUATIC FACILITY preventive maintenance inspections shall also include:

1) Monthly tests of GFCI devices and
2) Visual inspections of bonding conductors, where accessible, every 6 months or whenever disrupted or impacted by site construction or other related events.

6.4.1.4[A] Illness and Injury Incident Reports

6.4.1.4.1 Incidents to Record The owner/operator shall ensure that a record is made of all injuries and illness incidents at the AQUATIC FACILITY which:

1) Result in death;
2) Require resuscitation, CPR, oxygen, or AED use to be initiated;
3) Require transportation or treatment of a PATRON to a medical facility; or
4) Results in a PATRON being diagnosed with a RWI.

6.4.1.4.2 Info to Include Illness and injury incident report information shall include:

1) Date,
2) Time,
3) Location,
4) Incident including type of illness or injury and cause or mechanism,
5) Names and addresses of the individuals involved,
6) Actions taken,
7) Equipment used, and
8) Outcome of the incident.

6.4.1.4.3[A] Notify the AHJ In addition to making such records, the owner/operator shall ensure that the AHJ is notified within 24 hours of the occurrence of an incident recorded in MAHC 6.4.1.4.1.

6.4.1.4.4[A] Lifeguard Rescue Records The owner/operator shall also record all lifeguard rescues where the QUALIFIED LIFEGUARD enters the water and activates the aquatic EAP.

6.4.1.4.4.1 Info to Include These records shall include the date, time, QUALIFIED LIFEGUARD, and PATRON names and reason the rescue was needed.

6.4.1.5 Chemical Inventory Log A chemical inventory log shall be maintained onsite to provide a list of chemicals used in the AQUATIC VENUE water and surrounding DECK that could result in water quality issues, chemical interactions, or PATRON exposure.

6.4.1.5.1 Expiration Dates These records shall include the expiration date for water quality chemical testing reagents.

6.4.1.6[A] 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) pH;
2) Disinfectant residuals;
3) COMBINED CHLORINE concentrations;
4) Operating pressures of water recirculation pumps and filters or the corresponding flow rate from flow meter readings;
5) CYA concentrations, if used;

6) Maintenance and malfunctioning of equipment, including dates and time of all equipment calibration including WQTDs;

7) Dates of challenge testing of the chemical feeder interlock system as outlined in MAHC 5.7.3.5.1.4.1;

8) If heated, AQUATIC VENUE water temperature;

9) The time of filter backwash or cleaning;

10) Calcium hardness;

11) Total alkalinity;

12) Saturation index;

13) Microbiological testing, if applicable, dates/times samples were taken and results;

14) Any equipment failure, power outage, or error resulting in the interruption of the circulation, filtration, or DISINFECTION systems for more than 1 hour;

15) The daily attendance at the AQUATIC FACILITY. In POOLS where attendance is not ordinarily recorded, a guest sign in book can be used to track attendance,

16) SECONDARY TREATMENT as outlined in MAHC 5.7.3.7.7 and 5.7.3.7.8; and

17) Readings from the turbidity meter.

6.4.1.7 Staff Certifications on File The originals or copies of all required QUALIFIED LIFEGUARD, LIFEGUARD SUPERVISOR, or QUALIFIED OPERATOR certificates shall be maintained at the AQUATIC FACILITY and made available to AHJ, staff, and PATRONS upon request.

6.4.1.7.1 Multiple Facilities A copy of the original certificate shall be made available when employees work at multiple AQUATIC FACILITIES.

6.4.1.8[A] Bodily Fluids Remediation Log

6.4.1.8.1[A] Contamination Incidents A Body Fluid Contamination Response Log shall be maintained to document each occurrence of contamination of the water or its immediately adjacent areas by formed or diarrheal fecal material, whole stomach discharge of vomit, and blood.

6.4.1.8.2 Standard Operating Procedures The AQUATIC FACILITY'S STANDARD operating procedures for responding to these contamination incidents shall be readily available for review by the AHJ.

6.4.1.8.3 Required Information The log shall include the following information recorded at the time of the incident:

1) Person conducting response;

2) Qualified operator or onsite responsible supervisor on duty;

3) Date and time of incident response;

4) Specific area, if not in the water, contaminated by incident;

5) BATHER COUNT or reasonable approximation of the number of BATHERS in the AQUATIC VENUE at the time of incident (if applicable);

6) Type and form of body fluid observed (for example, diarrheal or formed stool, vomit, or blood);

7) Date and time when the area was closed;

8) Whether the POOL uses CHLORINE stabilizer and concentration at time of incident;

9) Residual disinfectant (e.g., DPD-FC) concentration and pH at the time of incident;

10) Remediation procedures used after the incident including contact time, if applicable;

11) Residual disinfectant (e.g., DPD-FC) concentration and pH at the time of reopening the AQUATIC VENUE to the public;

12) Stabilizer concentration, if used, at the time of reopening; and

13) Date and time of reopening.

6.4.2 Patron-Related Management Aspects

6.4.2.1 Bather Count

6.4.2.1.1[A] User Guidance AQUATIC FACILITIES shall have a plan in place to address fluctuations in BATHER occupancy to ensure proper maintenance and staffing.

6.4.2.1.2 Maximum Occupancy Such plans shall not exceed the maximum designed THEORETICAL PEAK OCCUPANCY for the individual AQUATIC VENUES or the AQUATIC FACILITY.

6.4.2.2[A] Signage

6.4.2.2.1 Facility Rules The operator shall post and enforce the AQUATIC FACILITY rules governing health, SAFETY, and sanitation.

6.4.2.2.2 Lettering The lettering shall be legible and at least 1 inch (25.4 mm or 3- point type) high, with a contrasting background.

6.4.2.2.3[A] Sign Messages Signage shall be placed in a conspicuous place at the entrance of the AQUATIC FACILITY communicating expected and prohibited behaviors and other information using text that complies with the intent of the following information:

1) In case of an emergency, dial 911 or other emergency instructions, per MAHC 6.3.4.5.8;
2) Hours of operation;
3) Theoretical peak occupancy
4) Pollution of AQUATIC VENUE prohibited;
5) Do not swim if you have open wounds
6) Do not swim if you are ill with diarrhea or vomiting,
7) SHOWER before entering the water;
8) No glass items in the AQUATIC VENUE or on the DECK;
9) Do not swallow or spit water;
10) Diaper changing on the DECK is prohibited;
11) No Diving, as applicable per MAHC 5.5.5;
12) Intentional hyperventilation or extended breath holding activities are dangerous and prohibited;
13) No animals in the AQUATIC VENUE and no animals on the DECK, except service animals, if applicable;
14) No rough play; and
15) Children must be supervised by a responsible adult (parent or caregiver) up to the minimum age established by the AQUATIC FACILITY.

6.4.2.2.3.1 Aquatic Facilities with Onsite Emergency Personnel MAHC 6.4.2.2.3 signage requirement number 1 may be amended to include onsite emergency staff contact information if emergency trained personnel are onsite so that the response would be faster than calling 911.

6.4.2.2.3.2 Diving Well AQUATIC FACILITIES with diving wells may amend signage requirement number 11 to read that diving is not allowed in all AQUATIC VENUES except for the diving well.

6.4.2.2.3.3 Posters Recreational water illness prevention posters shall be posted conspicuously in the AQUATIC FACILITY at all times.

6.4.2.2.3.4 Facilities without Lifeguards In addition to signage messages 1 through 13, unstaffed AQUATIC FACILITIES shall also include signage messages covering:

1) No Lifeguard on Duty: Children under the age of 14 years must have direct supervision by a person aged 18 years or older and
2) Hours of operation: AQUATIC FACILITY use prohibited at any other time.

6.4.2.2.3.4.1 Posters In AQUATIC FACILITIES not requiring lifeguards, CPR posters reflecting the latest STANDARDS shall be posted conspicuously at all times.

6.4.2.2.3.4.2 Automatic External Defibrillator When installed for public access, a location sign shall be provided clearly labeled "AED". This sign shall be mounted at a height of 7 feet (2.1 m) and comply with ISO 7010 and be visible from all directions of traffic.

6.4.2.2.3.5 Multiple Aquatic Venues For AQUATIC FACILITIES with multiple AQUATIC VENUES, MAHC 6.4.2.2.3 signage item numbers 3 and, if applicable, number 11, or text complying with the intent of the information, shall be posted at the entrance to each AQUATIC VENUE except such posting is not required at WATERSLIDES.

6.4.2.2.3.6 Movable Bottom Floor Signage In addition to the MAHC 6.4.2.2.3 requirements, AQUATIC VENUES with moveable bottom floors shall also have the following information or text complying with the intent of the following information:

1) A sign for AQUATIC VENUE water depth in use shall be provided and clearly visible;
2) A "NO DIVING" sign shall be provided; and
3) The floor is movable and AQUATIC VENUE depth varies.

6.4.2.2.3.7[A] Spa Signs In addition to the MAHC 6.4.2.2.3 requirements, SPAS shall also have the following information or text complying with the intent of the following information:

1) Maximum water temperature is 104° F (40°C);
2) Children under age 5 and people using alcohol or drugs that cause drowsiness shall not use SPAS;
3) Pregnant women and people with heart disease, high blood pressure or other health problems should not use SPAS without prior consultation with a healthcare provider;
4) Children under 14 years of age shall be supervised by an adult; and
5) Use of the SPA when alone is prohibited (if no lifeguards onsite).

6.4.2.2.4 Hygiene Facility Signage Signage shall be posted at the HYGIENE FACILITY exit used to access AQUATIC VENUES stating or containing information, or text complying with the intent of the following information:

1) Do not swim when ill with diarrhea;
2) Do not swim with open wounds and sores;

3) SHOWER before entering the water;
4) Check your child's swim diapers/rubber pants regularly;
5) Diaper changing on the DECK is prohibited;
6) Do not poop or pee in the water;
7) Do not swallow or spit water; and
8) Wash hands before returning to the POOL.

6.4.2.2.5[A] Diaper-Changing Station Signage Signage shall be posted at DIAPER-CHANGING STATIONS stating or containing information, or text complying with the intent of the following information:

1) Dispose of used disposable diapers in the diaper bucket or receptacle provided;
2) Dump contents from reusable diapers into toilets and bag diapers to take home;
3) Use the materials provided to clean/SANITIZE the surface of the DIAPER-CHANGING STATION before and after each use;
4) Wash your hands and your child's hands after diapering; and
5) Do not swim if ill with diarrhea.

6.4.2.3 Swimmer Empowerment Methods

6.4.2.3.1[A] Public Information and Health Messaging The owner/operator shall ensure that a public information and health messaging program to inform INDOOR AQUATIC FACILITY PATRONS of their impact on INDOOR AQUATIC FACILITY air quality is developed and implemented.

6.4.2.3.2[A] Post Inspection Results The results of the most recent AHJ inspection of the AQUATIC FACILITY shall be posted at the AQUATIC FACILITY in a location conspicuous to the public.

6.5[A] Fecal/Vomit/Blood Contamination Response

6.5.1[A] Contamination Response Plan

6.5.1.1 Contamination Response Plan All AQUATIC FACILITIES shall have a CONTAMINATION RESPONSE PLAN within the EAP for responding to formed-stool contamination, diarrheal-stool contamination, vomit contamination, and contamination involving blood.

6.5.1.2 Contamination Training The CONTAMINATION RESPONSE PLAN shall include procedures for response and cleanup, provisions for training staff in these procedures, and a list of equipment and supplies for cleanup.

6.5.1.2.1[A] Minimum A minimum of one person onsite while the AQUATIC FACILITY is open for use shall be:

1) Trained in the procedures for response to formed-stool contamination, diarrheal contamination, vomit contamination, and blood contamination and
2) Trained in PPE and other OSHA measures including the Bloodborne Pathogens Standard 29 CFR 1910.1030 to minimize exposure to bodily fluids that may be encountered as employees in an aquatic environment.

6.5.1.2.2 Informed Staff shall be informed of any updates to the response plan.

6.5.1.3 Equipment and Supply Verification The availability of equipment and supplies for remediation procedures shall be verified by the QUALIFIED OPERATOR at least weekly.

6.5.1.4 Plan Review The response plan shall be reviewed at least annually and updated as necessary.

6.5.1.5 Plan Availability The response plan shall be kept onsite and available for viewing by the AHJ.

6.5.2 Aquatic Venue Water Contamination Response

6.5.2.1 Closure In the event of a fecal or vomit contamination in an AQUATIC VENUE, the QUALIFIED OPERATOR shall immediately close the AQUATIC VENUE to swimmers until remediation procedures are complete.

6.5.2.1.1 Closure Includes This closure shall include the affected AQUATIC VENUE and other AQUATIC VENUES that share the same RECIRCULATION SYSTEM.

6.5.2.2 Physical Removal Contaminating material shall be removed (e.g., using a net, scoop, or bucket) and disposed of in a sanitary manner.

6.5.2.2.1 Clean / Disinfect Net or Scoop Fecal or vomit contamination of the item used to remove the contamination (e.g., the net or bucket) shall be removed by thorough cleaning followed by DISINFECTION (e.g., after cleaning, leave the net, scoop, or bucket immersed in the POOL during the DISINFECTION procedure prescribed for formed-stool, diarrheal-stool, or vomit contamination, as appropriate).

6.5.2.2.2[A] No Vacuum Cleaners Aquatic vacuum cleaners shall not be used for removal of contamination from the water or adjacent surfaces unless vacuum waste is discharged to a sanitary sewer and the vacuum equipment can be adequately disinfected.

6.5.2.3[A] Treated AQUATIC VENUE water that has been contaminated by feces or vomit shall be treated as follows:

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 DPD-FC concentration during the remediation process;
4) Test the FREE CHLORINE RESIDUAL at multiple sampling points to ensure the proper DPD-FC concentration is achieved throughout the POOL for the entire DISINFECTION time; and
5) Use only non-stabilized CHLORINE products to raise the DPD-FC concentrations during the remediation.

6.5.3 Aquatic Venue Water Contamination Disinfection

6.5.3.1[A] Formed-Stool Contamination Formed-stool contaminated water shall have the DPD-FC concentration checked and the DPD-FC concentration raised to 2.0 ppm (mg/L) (if less than 2.0 ppm [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[A] Pools Containing Chlorine Stabilizers In AQUATIC VENUE water that contains CYA, 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 DPD-FC concentration.

6.5.3.2[A] Diarrheal-Stool Contamination In an AQUATIC VENUE with diarrheal stool contaminated water, the qualified operator shall:

1) Check the DPD-FC concentration and then raise the DPD-FC concentration to at least 20.0 ppm (mg/L) and maintain for at least 12.75 hours (or an equivalent time and concentration to reach the CT INACTIVATION VALUE of 15,300 mg min/L) before reopening the AQUATIC VENUE or

2) Circulate the water through a SECONDARY TREATMENT 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[A] 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 (mg/L) by draining and then refilling with water from the approved water source per MAHC 4.11.1, if necessary;

   c) Raising the DPD-FC concentration to 20 ppm (mg/L); 30 ppm (mg/L); or 40 ppm (mg/L) for at least the corresponding inactivation time (in hours) in MAHC table 6.5.3.2.1, 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 DPD-FC concentration or;

2) Circulating the water through a SECONDARY TREATMENT 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 or;

3) Draining the AQUATIC VENUE completely.

Table 6.5.3.2.1: Inactivation Time

Initial [CYA] (mg/L)	% of pool drained/refilled	Log-reduction by draining	Inactivation time for 20 ppm DPD-FC	Inactivation time for 30 ppm DPD-FC	Inactivation time for 40 ppm DPD-FC
≤ 15	0	0	28 hours	18 hours	8.5 hours
30	50%	0.30	25.2 hours	16.2 hours	7.7 hours
50	70%	0.52	23.2 hours	14.9 hours	7.0 hours
70	79%	0.67	21.8 hours	14.0 hours	6.6 hours
90	83%	0.78	20.7 hours	13.3 hours	6.3 hours

6.5.3.3[A] Vomit-Contamination Vomit-contaminated water shall have the DPD-FC concentration checked and the DPD-FC concentration raised to 2.0 ppm (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.

6.5.3.3.1 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 6.5.3.3.

6.5.3.3.2 Measurement of the Inactivation Time Measurement of the inactivation time required shall start when the AQUATIC VENUE reaches the intended DPD-FC concentration .

6.5.3.4[A] Blood-Contamination Blood contamination of a properly maintained AQUATIC VENUE'S water does not pose a public health risk to swimmers.

6.5.3.4.1 Operators Choose Treatment Method Operators may choose whether or not to close the AQUATIC VENUE and treat as a formed stool contamination as in MAHC 6.5.3.1 to satisfy PATRON concerns.

6.5.3.5[A] Procedures for Brominated Pools Formed-stool, diarrheal-stool, or vomit-contaminated water in a brominated AQUATIC VENUE shall have CHLORINE added to the AQUATIC VENUE in an amount that will increase the DPD-FC concentration to the concentration specified for the specific type of contamination for the specified time.

6.5.3.5.1 Bromine Residual The bromine residual shall be adjusted, if necessary, before reopening the AQUATIC VENUE.

6.5.3.6[A] *Legionella* Contamination

6.5.3.6.1 Remediation and Testing For remediation and testing of AQUATIC VENUES suspected of being contaminated with *Legionella* the QUALIFIED OPERATOR shall:

1) Close the SPA tub to BATHERS immediately, shut down the hydrotherapy jet system and circulation pumps, but do not drain the water.
2) Contact the state or local public health AHJ for information about laboratory testing for *Legionella*. If the health department determines that laboratory testing is needed, water and biofilm samples should be taken from the SPA tub water line, hydrotherapy jets, filters/filter media, and compensation tank to test for *Legionella* by culture before taking the steps below. If an outbreak or illness is suspected, sampling and laboratory testing should always be done in collaboration with your state or local public health agency and a laboratory with *Legionella* testing expertise.
3) Proceed as directed below after samples have been taken; it is not necessary to wait for laboratory test results. However, the SPA should not be reopened to BATHERS until all test results are negative for *Legionella*.
4) Drain all water from the SPA after collection of samples per public health instructions. Dispose of the water to waste or as directed by the local regulatory authority.
5) Scrub vigorously all SPA surfaces, skimming devices and weirs, circulation components with DPD-FC at a minimum concentration of 5 ppm (mg/L) to remove any biofilm or slime. After scrubbing, rinse the SPA with clean water and flush to waste.
6) Replace filters (for cartridge or DE filters) or filter media (for sand filters). Bag these filters and dispose as normal solid waste.
7) Inspect the SPA thoroughly for any broken or poorly functioning components such as valves, sensors, tubing, or disinfectant feeders. Make any needed repairs.
8) Refill the SPA with clean water.
9) Hyperchlorinate using 20 ppm (mg/L) DPD-FC.
    a) Keep the hydrotherapy jet system off and let the hyperchlorinated water circulate for 1 hour in all of the components of the SPA including the compensation/surge tank, filter housing, and piping.
    b) Turn on the hydrotherapy jet system to circulate the hyperchlorinated water for 9 additional hours. Ensure that 20 ppm (mg/L) of DPD-FC is maintained in the system for the entire 10 hours.
10) Flush the entire system to remove the hyperchlorinated water from all equipment.

11) Refill the SPA with clean water and return the SPA to the routine disinfectant level. Maintain routine disinfectant levels for at least 48 hours prior to collecting samples for *Legionella* testing.

12) Take repeat samples for culture-based laboratory testing to confirm that *Legionella* has been eliminated. Water and biofilm samples should be taken from the SPA tub, water line, hydrotherapy jet system, filters/filter media, compensation tank and any part of the SPA that originally tested positive for *Legionella*.

13) Keep the SPA closed to BATHERS until this repeat testing has confirmed the elimination of *Legionella*. If laboratory testing is positive for *Legionella*, repeat steps 4–11 until all testing is negative for *Legionella*. When all tests are negative, the SPA can be reopened to BATHERS.

14) Ensure that halogen (CHLORINE or bromine) concentration and pH meet applicable local, state, territorial, federal, and tribal laws before reopening the SPA to BATHERS. Maintain water quality according to local, state, territorial, federal, and tribal laws.

15) If the SPA is associated with an outbreak, conduct additional sample testing during the weeks and/or months after remediation to validate efficacy of control measures to prevent recurrence of *Legionella*, with the timing to be determined by the AHJ. If at any time during this laboratory testing schedule *Legionella* is found, disinfect again and start the follow-up testing over. For AQUATIC VENUES that continue to grow *Legionella*, consider hiring a consultant with expertise in *Legionella* control.

6.5.4 Surface Contamination Cleaning and Disinfection

6.5.4.1[A] Limit Access If a bodily fluid, such as feces, vomit, or blood, has contaminated a surface in an AQUATIC FACILITY, facility staff shall limit access to the affected area until remediation procedures have been completed.

6.5.4.2[A] Clean Surface Before DISINFECTION, all visible CONTAMINANT shall be cleaned and removed with disposable cleaning products effective with regard to type of CONTAMINANT present, type of surface to be cleaned, and the location within the facility.

6.5.4.3[A] Contaminant Removal and Disposal CONTAMINANT removed by cleaning shall be disposed of in a sanitary manner or as required by law.

6.5.4.4[A] Disinfect Surface Contaminated surfaces shall be disinfected with one of the following DISINFECTION solutions:

1) A 1:10 dilution of fresh household bleach with water or

2) An equivalent EPA–REGISTERED disinfectant that has been approved for body fluids DISINFECTION.

6.5.4.5 Soak The disinfectant shall be left to soak on the affected area for a minimum of 20 minutes or as otherwise indicated on the disinfectant label directions.

6.5.4.6 Remove Disinfectant shall be removed by cleaning and shall be disposed of in a sanitary manner or as required by the AHJ.

6.6 AHJ Inspections

6.6.1[A] Inspection Process

6.6.1.1 Inspection Authority The AHJ shall have the right to inspect or investigate the operation and management of an AQUATIC FACILITY.

6.6.1.2 Inspection Scope and Right Upon presenting proper identification, an authorized employee or agent of the AHJ shall have the right to and be permitted to enter any AQUATIC FACILITY or AQUATIC

VENUE area, including the recirculation equipment and piping area, at any reasonable time for the purpose of inspecting the AQUATIC VENUE or AQUATIC FEATURES to do any of the following:

1) Inspect, investigate, or evaluate for compliance with this CODE;
2) Verify compliance with previously written violation orders;
3) Collect samples or specimens;
4) Examine, review, and copy relevant documents and records;
5) Obtain photographic or other evidence needed to enforce this CODE; or
6) Question any person.

6.6.1.3 Based on Risk An AQUATIC FACILITY'S inspection frequency may be amended based on a risk of recreational water injury and illness.

6.6.1.4 Inspection Interference It is a violation of this CODE for a person to interfere with, deny, or delay an inspection or investigation conducted by the AHJ.

6.6.2 Publication of Inspection Forms

6.6.2.1 Inspection Form Publication The AHJ may publish or post on the web or other source the reports of AQUATIC FACILITY inspections.

6.6.3 Imminent Health Hazards

6.6.3.1[A] Violations Requiring Immediate Correction or Closure The AHJ shall have the right to order immediate correction or order immediate POOL closure for any of the following IMMINENT HEALTH HAZARDS violations:

1) Failure to provide supervision and staffing of the AQUATIC FACILITY as prescribed in MAHC 6.3.4.1;
2) Failure to provide the minimum disinfectant residual concentrations listed in MAHC 5.7.3.1;
3) Disinfectant residual concentrations that exceed maximum level while BATHERS are present (CHLORINE-DPD-FC above 10 ppm (mg/L), Bromine above 8.0 ppm (mg/L));
4) AQUATIC VENUES using CHLORINE STABILIZERS where the CYA:DPD-FC ratio exceeds 45:1
5) pH below 6.5;
6) pH above 8.0;
7) Failure to continuously operate the AQUATIC VENUE filtration and DISINFECTION equipment;
8) Use of an unapproved or contaminated water supply source for potable water use;
9) Failure to provide interlock controls and flow meters/flow switches/pressure switches in accordance with section 4.7.3.2.1.3, or the flow meters/flow switches/pressure switches are not operating properly, or the flow meters/flow switches/pressure switches have been disabled or bypassed;
10) Unprotected overhead electrical wires within 20 feet horizontally of the AQUATIC VENUE;
11) Non GFCI protected electrical receptacles within 20 feet of the inside wall of the AQUATIC VENUE;
12) Failure to maintain an emergency lighting source;
13) Absence of all required lifesaving equipment on DECK;
14) AQUATIC VENUE bottom not visible;
15) Total absence of or improper depth markings at an AQUATIC VENUE;

16) Plumbing CROSS-CONNECTIONS between the drinking water supply and AQUATIC VENUE water or between sewage system and the AQUATIC VENUE including filter backwash facilities;

17) Failure to provide and maintain an ENCLOSURE to prevent unauthorized access to the AQUATIC FACILITY or AQUATIC VENUE when required;

18) Failure to prevent unauthorized access to the CHEMICAL STORAGE SPACES as required in MAHC 4.9.2.3;

19) Use of unapproved chemicals or the application of chemicals by unapproved methods to the AQUATIC VENUE water;

20) Broken, unsecured, or missing main drain grate or any submerged suction outlet grate in the AQUATIC VENUE;

21) Number of BATHERS/patrons exceeds the theoretical peak occupancy;

22) Broken glass or sharp objects in AQUATIC VENUE or on DECK area;

23) CYA concentration that exceeds maximum level of 300 ppm (mg/L) while BATHERS are present; or

24) Any other item determined to be a public health hazard by the AHJ.

6.6.3.1.1 Low pH Violations If pH testing equipment does not measure below 6.5, pH must be at or below the lowest value of the test equipment.

6.6.3.1.2 High pH Violations If pH testing equipment does not measure above 8.0, pH must be at or above the highest value of the test equipment.

6.6.3.2 Required Closing An AQUATIC FACILITY owner, QUALIFIED OPERATOR, or RESPONSIBLE SUPERVISOR of an AQUATIC FACILITY shall close an AQUATIC VENUE for any of the IMMINENT HEALTH HAZARDS in MAHC 6.6.3.1.

6.6.4 Enforcement

6.6.4.1 Placarding of Pool Where an IMMINENT HEALTH HAZARD is found and remains uncorrected, the AQUATIC VENUE shall be placarded to prohibit use until the hazard is corrected in order to protect the public health or SAFETY of BATHERS.

6.6.4.2 Placard Location When a placard is used, it shall be conspicuously posted at each entrance leading to the AQUATIC VENUE.

6.6.4.2.1 State Authority When placed by the AHJ, the placard shall state the authority responsible for its placement.

6.6.4.2.2 Tampering with Placard When placed by the AHJ, the placard shall indicate that concealment, mutilation, alteration, or removal of it by any person without permission of the AHJ shall constitute a violation of this CODE.

6.6.4.3 Operator Follow-up Within 15 days of the AHJ placarding an AQUATIC FACILITY, the operator of such AQUATIC FACILITY shall be provided with an opportunity to be heard and present proof that continued operation of the facility does not constitute a danger to the public health.

6.6.4.3.1 Correction of Violation If the IMMINENT HEALTH HAZARD(S) have been corrected, the operator may contact the AHJ prior to the hearing and request a follow-up inspection.

6.6.4.3.2 Hearing The hearing shall be conducted by the AHJ.

6.6.4.4 Follow-up Inspection The AHJ shall inspect the premises within two working days of notification that the hazard has been eliminated to remove the placards after verifying correction.

6.6.4.4.1 Other Evidence of Correction The AHJ may accept other evidence of correction of the hazard in lieu of inspecting the premises.

6.6.5[A] Enforcement Penalties

6.6.5.1 Liability and Jurisdiction It shall be a violation for any person to fail to comply with any of the regulations promulgated pursuant to this CODE and as adopted by the AHJ.

6.6.5.1.1 Failure to Comply Any person who fails to comply with any such regulation shall be in violation of this CODE.

6.6.5.1.2 Civil Penalties For each such offense, violators shall be liable for civil penalties including, but not limited to, monetary fines, training requirements, repair or rehabilitation of physical structure or machinery, or suspension or revocation of the operation permit.

6.6.5.2 Continued Violation Each day, or any part thereof, during which a willful violation of this CODE exists or persists shall constitute a separate violation of this CODE.

6.6.5.3 Falsified Documents Falsifying or presenting to the AHJ falsified documentation and or certificates shall be a civil violation as specified by the AHJ.

6.6.5.4 Enforcement Process Upon determining that one or more violations of this CODE exists, the AHJ shall cause a written notice of the violation or violations to be delivered to the owner or operator of the AQUATIC FACILITY that is in violation of this CODE.

7.0 Special Venues

The provisions of Chapter 7 (Special Venues) apply to construction of a new AQUATIC VENUE or SUBSTANTIAL ALTERATION to an existing AQUATIC VENUE, unless otherwise noted.

Note: Section numbers with superscript "A" (e.g., 7.0[A]) denote a corresponding discussion in the Annex to the Model Aquatic Health Code.

7.1[A] Floatation Tank Design and Construction

7.1.1 Design and Construction

7.1.1.1[A] Design and Construction Only the design and construction provisions contained in MAHC 7.1.1 thru 7.1.11 apply to construction of a new FLOATATION TANK facility or FLOATATION TANK or SUBSTANTIAL ALTERATION to an existing FLOATATION TANK facility or FLOATATION TANK, unless otherwise noted.

7.1.1.2 Plan Submittal

7.1.1.2.1 Purpose FLOATATION TANK facility construction plans shall be designed to provide sufficient clarity to indicate the location, nature, and extent of the work proposed.

7.1.1.2.2 Conform FLOATATION TANK facility construction plans shall show in detail that it will conform to the provisions of this CODE and all applicable local, state, territorial, federal, and tribal laws as determined by the AHJ and to protect the health and SAFETY of the AQUATIC FACILITY'S BATHERS and PATRONS.

7.1.1.2.3 Approved Plans No person shall begin to construct a new FLOATATION TANK facility or shall substantially alter an existing FLOATATION TANK facility without first having the construction plans detailing the construction or SUBSTANTIAL ALTERATION submitted to and approved by the AHJ.

7.1.1.2.4 Plan Preparation All plans shall be prepared by a DESIGN PROFESSIONAL who is registered or licensed to practice their respective design profession as defined by the local, state, territorial, federal, and tribal laws governing professional practice within the jurisdiction in which the project is to be constructed.

7.1.1.2.5 Required Statements All construction plans shall include the following statements:

1) "The proposed floatation tank facility and all equipment shall be constructed and installed in conformity with the approved plans and specifications or approved amendments;" and
2) "No substantial alteration, changes, additions, or equipment not specified in the approved plans or allowed in the code can be made or added until the plans for such substantial alteration, changes, additions, or equipment are submitted to and approved by the AHJ."

7.1.1.3 Content of Design Report

7.1.1.3.1 Names / Addresses FLOATATION TANK facility plans shall include the name, address, and contact information for the owner, designer, and builder if available at the time of submission.

7.1.1.4 Plans and Specifications

7.1.1.4.1 Drawings Detailed scaled and dimensional drawings for each individual FLOATATION TANK shall include an area plan and layout plan along with dimensioned longitudinal and transverse cross sections of the FLOATATION TANK.

7.1.1.4.2 Operating Conditions The design documents shall include a record of operating conditions (FLOATATION TANK SOLUTION temperature(s), space temperature, space relative humidity, space dew point) accepted by both the design engineer and owner/operator.

7.1.1.4.3 Floatation Tank Attributes Detailed scaled and dimensional drawings for each individual FLOATATION TANK shall include location and type of:

1) INLETS;
2) Overflows;
3) Drains;
4) Suction outlets;
5) Overflow gutters or devices;
6) Piping;
7) Designed water elevation;
8) Features, such as ladders and stairs;
9) Lighting;
10) Markings; and
11) Surface materials.

7.1.1.4.4 Area Design Detailed scaled and dimensional drawings of the FLOATATION TANK facility and for each individual FLOATATION TANK, as appropriate, shall include location and type of:

1) Design of floors and walls enclosing the FLOATATION TANK,
2) Floor drains,
3) SLIP-RESISTANT flooring,
4) FLOATATION TANK room area finishes,
5) Drinking fountains or other sources of drinking water,
6) Entries and exits,
7) Hose bibs, and
8) Area lighting.

7.1.1.4.5 Floatation Tank Recirculation and Treatment Design Detailed scaled and dimensional drawings for each individual FLOATATION TANK shall contain a flow diagram showing the location, plan, elevation, and schematics of:

1) Filters;
2) Pumps;
3) Disinfection systems;
4) SUPPLEMENTAL TREATMENT systems, if installed;
5) Ventilation devices or AIR HANDLING SYSTEMS;
6) Heaters;
7) BACKPRESSURE prevention assemblies and air gaps;
8) Valves;
9) Piping;
10) Flow meters;

11) Gauges;

12) Thermometers;

13) Test cocks;

14) Sight glasses; and

15) Drainage system for the disposal of FLOATATION TANK water and filter wastewater.

7.1.1.4.6 Equipment Room Design Detailed scaled and dimensional drawings for each individual FLOATATION TANK shall contain a schematic layout of the FLOATATION TANK EQUIPMENT ROOM (or EQUIPMENT ROOM OR AREA if permitted by the AHJ) showing accessibility for installation and maintenance.

7.1.1.4.7 Chemical Storage Space Design Detailed scaled and dimensional drawings for each individual FLOATATION TANK shall contain a schematic layout of the FLOATATION TANK facility CHEMICAL STORAGE SPACE(S).

7.1.1.4.8 Hygiene Facility Design Detailed scaled and dimensional drawings for each FLOATATION TANK facility shall show the location and number of all available HYGIENE FACILITIES provided including dressing rooms, lockers, SHOWERS, lavatory, and toilet FIXTURES.

7.1.1.4.9 Plan Approval

7.1.1.4.9.1 .....New Construction

7.1.1.4.9.1.1 Approval Limitations The AHJ shall clearly state on the plans the limitations of their approval.

7.1.1.4.9.1.2 Other Approvals The approval shall also state that it is independent of all other required approvals such as Building, Zoning, Fire, Electrical, Structural, and any other approvals as required by local, state, territorial, federal, and tribal laws and the applicant must separately obtain all other required approvals and permits.

7.1.1.4.9.1.3 Plan Review Coordination The AHJ shall coordinate their FLOATATION TANK plan review and communicate their approval with other agencies involved in the FLOATATION TANK facility construction.

7.1.1.4.9.1.4 Plan Review Report The AHJ shall provide a plan submission compliance review list to the FLOATATION TANK facility owner with the following information:

1) Categorical items marked satisfactory, unsatisfactory, not applicable, or insufficient information;
2) A comment section keyed to the compliance review list shall detail unsatisfactory and insufficient;
3) Indication of the AHJ approval or disapproval of the AQUATIC FACILITY construction plans;
4) In the case of a disapproval, specific reasons for disapproval and procedure for resubmittal; and
5) Reviewer's name, signature, and date of review.

7.1.1.4.9.1.5 Plans Maintained The FLOATATION TANK facility owner shall maintain at least one set of their own approved plans made available to AHJ onsite for as long as the FLOATATION TANK facility is in operation.

7.1.1.4.9.2 .....Non-Substantial Alterations

7.1.1.4.9.2.1 Alteration Review The FLOATATION TANK facility owner planning a NON-SUBSTANTIAL ALTERATION shall contact the AHJ to review proposed changes prior to starting the NON-SUBSTANTIAL ALTERATION.

7.1.1.4.9.2.2 Alteration Scope The FLOATATION TANK facility operator shall consult with the AHJ to determine if new or modified plans must be submitted for plan review and approval for other NON-SUBSTANTIAL ALTERATIONS proposed.

7.1.1.4.9.3 Replacements

7.1.1.4.9.3.1 Replacement Approval Prior to replacing equipment, the FLOATATION TANK facility owner shall submit technical verification to the AHJ that all replacement equipment is equal to that which was originally approved and installed.

7.1.1.4.9.3.2 Replacement Equipment Equivalency The replacement of pumps, filters, feeders, controllers, SKIMMERS, flow-meters, valves, or other similar equipment with identical or substantially similar equipment may be done without submission to the AHJ for approval of new or altered AQUATIC FACILITY plans.

7.1.1.4.9.3.3 Emergency Replacement In emergencies, the replacement may be made prior to receiving the AHJ's approval, with the owner accepting responsibility for proper immediate replacement if the equipment is not deemed equivalent by the AHJ.

7.1.1.4.9.3.3.1 Documentation Where emergency replacements are installed as per MAHC 7.1.1.4.11.3, the owner shall submit documentation for review and approval of the replacement to the AHJ within 45 days.

7.1.1.4.9.3.4 Replacement Record Maintenance The AHJ shall provide the FLOATATION TANK facility owner written approval or disapproval of the proposed replacement equipment's equivalency.

7.1.1.4.9.3.5 Documentation Documentation of proposed, approved, and disapproved replacements shall be maintained in the AHJ's FLOATATION TANK facility files.

7.1.1.4.9.4 Compliance Certificate

7.1.1.4.9.4.1 Construction Compliance Certificate A certificate of construction compliance shall be submitted to the AHJ for all FLOATATION TANK facility plans for new construction and SUBSTANTIAL ALTERATIONS requiring AHJ approvals.

7.1.1.4.9.4.2 Certificate Preparation This certificate shall be prepared by a licensed professional and be within the scope of their practice as defined by the local, state, territorial, federal, and tribal laws governing professional practice within the jurisdiction of the permit issuing official.

7.1.1.4.9.4.3 Certificate Statement The certificate shall also include a statement that the FLOATATION TANK facility, all equipment, and appurtenances have been constructed and/or installed in accordance with approved plans and specifications.

7.1.1.4.9.4.4 Systems Commissioning If commissioning or testing reports for systems such as FLOATATION TANK facility lighting, air handling, recirculation, filtration, and/or DISINFECTION are conducted, then those reports shall be included in furnished documentation.

7.1.1.4.9.4.5 Maintenance Documentation of FLOATATION TANK facility new construction or SUBSTANTIAL ALTERATION plan compliance shall be maintained in the AHJ's FLOATATION TANK facility files.

7.1.1.4.9.5 Construction Permits

7.1.1.4.9.5.1 Construction Permits for Building Construction permits required in this CODE and all other applicable permits shall be obtained before any FLOATATION TANK facility may be constructed.

7.1.1.4.9.5.2 Construction Permit for Remodeling A construction permit or other applicable permits may be required from the AHJ before SUBSTANTIAL ALTERATION of a FLOATATION TANK facility.

7.1.1.4.9.5.3 Issuance The AHJ shall issue a construction permit to the owner to:

1) After receiving a certificate of completion from the DESIGN PROFESSIONAL verifying information submitted, and
2) When new construction, SUBSTANTIAL ALTERATIONS, or annual renewal requirements of this CODE have been met.

7.1.1.4.9.5.4 Denial The construction permit (license) may be withheld, suspended, or revoked by the AHJ for noncompliance of the FLOATATION TANK facility with the requirements of this CODE, and the owner will be provided:

1) Specific reasons for disapproval and procedure for resubmittal;
2) Notice of the rights to appeal this denial and procedures for requesting an appeal; and
3) Reviewer's name, signature and date of review and denial.

7.1.1.4.9.5.5 Documentation Documentation of FLOATATION TANK facility construction permit renewal or denial shall be maintained in the AHJ's FLOATATION TANK facility files.

7.1.1.4.9.5.6 Suspension or Revocation The AHJ shall revoke a construction permit or approval issued by the provisions of this code in case of any false statement or misrepresentation of fact in the application or on the construction documents on which the approval was based.

7.1.2 Materials

7.1.2.1 Construction Material FLOATATION TANKS shall be constructed of impervious and structurally sound material(s).

7.1.2.1.1 Smooth and Easily Cleaned Construction materials shall provide a smooth, easily cleaned, watertight structure.

7.1.2.1.2 Withstand Anticipated Loads The structure shall be capable of withstanding the anticipated stresses/loads for full and empty conditions.

7.1.2.1.3 Hydrostatic Conditions The structural design shall take into consideration hydrostatic conditions and the integration of the FLOTATION TANK with other structural conditions as required by applicable CODES.

7.1.2.2 Durability All materials shall be inert, non-toxic, resistant to corrosion, impervious, enduring, and resistant to damages related to environmental conditions of the installation region.

7.1.2.3 Watertight FLOATATION TANK shall be designed in such a way to maintain their ability to retain the designed amount of water.

7.1.2.4 Smooth Finish All walls shall have a durable finish suitable for regular scrubbing and cleaning at the waterline.

7.1.3 Equipment Standards

7.1.3.1 General

7.1.3.1.1 Accredited Standards Where applicable, all equipment used or proposed for use in floatation tank facilities governed under this CODE shall be:

1) Of a proven design and construction, and
2) CERTIFIED, LISTED, AND LABELED to a specific STANDARD for the specified equipment use by an ANSI- accredited certification organization.

7.1.3.1.2 No Standards Where STANDARDS do not exist, technical documentation shall be submitted to the AHJ to demonstrate acceptability for use in AQUATIC FACILITIES.

7.1.3.1.2.1 Proof of Acceptability The AHJ shall have the authority to require tests, as proof of acceptability.

7.1.4[A] Floatation Tank Electrical Systems and Components

7.1.4.1 General Guidance

7.1.4.1.1 ***NEC Requirements*** Electrical wiring and systems shall comply with the requirements of the NEC.

7.1.4.1.1.1 Providing Relief Nothing in this CODE shall be construed as providing relief from any applicable requirements of the NEC or other applicable CODE.

7.1.4.1.2 ***Indoor Aquatic Facilities*** A FLOATATION TANK and room containing a FLOATATION TANK shall be considered a wet and corrosive environment.

7.1.5 Food and Drink Concessions

7.1.5.1 Meet AHJ Requirements Concessions for food and drink in a FLOATATION TANK facility shall meet all AHJ requirements.

7.1.6 Water Supply/Wastewater Disposal

7.1.6.1 Water Supply Water serving a FLOATATION TANK facility shall be supplied from a potable water source.

7.1.6.2 Sanitary Wastes

7.1.6.2.1 ***Discharged*** Wastewater from all PLUMBING FIXTURES in the entire FLOATATION TANK facility shall be discharged to a municipal sanitary sewer system, if available.

7.1.6.2.2 ***Onsite Sewer System*** If a municipal sanitary sewer system is not available, all wastewater shall be disposed to an onsite sewer system that is properly designed to receive the entire wastewater capacity.

7.1.6.3 Floatation Tank Wastewater Wastewater/FLOATATION TANK SOLUTION from a FLOATATION TANK, including filter backwash water, shall be discharged to a sanitary sewer system having sufficient capacity to collect and treat wastewater or to an onsite sewage disposal system designed for this purpose.

7.1.7 Circulation System

7.1.7.1 Hydraulically Balanced The RECIRCULATION SYSTEM shall be hydraulically balanced to ensure effective distribution of treated water.

7.1.7.2 Filter Sizing Filtration system components shall be designed and sized to meet the applicable volumetric TURNOVER requirements specified in MAHC 7.2.9.

7.1.7.3 Pump Sizing Pump(s) shall be designed and sized to meet the applicable volumetric TURNOVER requirements specified in MAHC 7.2.9.

7.1.7.4 Submerged Suction Fittings or Suction Outlets Submerged suction fittings or suction outlets shall be CERTIFIED, LISTED, AND LABELED to ANSI/APSP-16 2017 by an ANSI-accredited organization.

7.1.8[A] Disinfection

7.1.8.1 Disinfection Types DISINFECTION shall be provided by either:

1) Ozone treatment system; or
2) UV treatment system.

7.1.8.2 Ozone and UV Disinfection Systems Ozone and UV DISINFECTION systems when used as the primary DISINFECTION system, shall meet the 3-log reduction of influent bacteria DISINFECTION efficacy as tested in accordance with the criteria specified in Annex H.1 of NSF/ANSI 50-2017 at the design filtration flow rate.

7.1.8.3 Ozone Disinfection When an Ozone DISINFECTION system is used, the criteria for ozone concentration and ozone production testing specified in Annex H.2 and H.3 respectively, of NSF/ANSI 50-2017 must be met.

7.1.8.3.1 Ozone Concentrations Ozone concentrations in the FLOATATION TANK SOLUTION shall not exceed 0.1 ppm (e).

7.1.8.4 UV Disinfection When a UV DISINFECTION system is used as the primary DISINFECTION system, the following must be provided:

1) Calibrated UV sensors shall be installed per MAHC 4.7.3.3.3.5; and
2) If the UV equipment fails to produce the required dosage as measured by the automated sensor, an alarm or other indication shall be initiated to alert staff.

7.1.9[A] Ventilation

7.1.9.1 Room Air Handling System AIR HANDLING SYSTEM(S) shall be provided when necessary for the room containing FLOATATION TANK(S) and shall be designed, constructed, and installed to support the health and SAFETY of the FLOATATION TANK facility PATRONS.

7.1.9.2 Tank Air Quality Ventilation serving the FLOATATION TANK shall be provided when necessary to ensure acceptable air quality for human health within the FLOATATION TANK.

7.1.10 Floors

7.1.10.1 Floors Floors in room containing FLOATATION TANK(S) shall have a smooth, easy-to-clean, impervious-to-water, SLIP-RESISTANT surface.

7.1.10.1.1 Floor Drains Floor drains shall be installed in rooms containing FLOATATION TANKS and dressing areas where PLUMBING FIXTURES are located.

7.1.10.1.1.1 Opening Grill Covers Floor drain opening grill covers shall be ½-inch (1.3 cm) or less in width or diameter.

7.1.10.1.1.2 Sloped to Drain Floors shall be sloped to drain water or other liquids.

7.1.11 Cleansing Showers CLEANSING SHOWERS shall be provided in or immediately available/accessible to the room containing the FLOATATION TANK(S).

7.2 Floatation Tank Operation

7.2.1 Operating Permits

7.2.1.1 Owner Responsibilities

7.2.1.1.1 Operating Permit Required Prior to opening to the public, the FLOATATION TANK Facility owner shall apply to the AHJ for an operating permit.

7.2.1.1.2 Separate An operating permit is required for newly constructed or substantially altered FLOATATION TANK at an existing FLOATATION TANK facility.

7.2.1.1.3 Prior to Issuance Before a permit to operate is issued, the following procedures shall be completed:

1) The FLOATATION TANK facility owner has demonstrated the FLOATATION TANK facility, including all newly constructed or substantially altered FLOATATION TANKS, is in compliance with the requirements of this CODE, and
2) The AHJ has approved the FLOATATION TANK facility to be open to the public.

7.2.1.1.4 ***Details*** The operating permit shall:

1) Be issued in the name of the owner,
2) List all FLOATATION TANKS included under the operating permit, and
3) Specify the period of time approved by the AHJ.

7.2.1.1.5 ***Expiration*** Operating permits shall terminate according to the AHJ schedule.

7.2.1.1.6 ***Renewal*** The FLOATATION TANK facility owner shall renew the operating permit prior to the scheduled expiration of an existing operating permit for a FLOATATION TANK facility.

7.2.1.1.7 ***Denial*** The operating permit may be denied or withheld, suspended or revoked by the AHJ for noncompliance of the FLOATATION TANK facility with the requirements of this CODE.

7.2.1.1.8 ***Owner Responsibilities*** The owner of a FLOATATION TANK facility is responsible for the facility being operated and managed in accordance with the requirements of this CODE.

7.2.1.2 Operating Permits

7.2.1.2.1 ***Location*** The operating permit shall be posted at the FLOATATION TANK facility in a location conspicuous to the public.

7.2.1.2.2 ***Operating Without an Operating Permit*** Operation of a FLOATATION TANK facility or newly constructed or substantially altered FLOATATION TANK without an operating permit shall be prohibited.

7.2.1.2.3 ***Required Closure*** The AHJ may order a newly constructed or substantially altered FLOATATION TANK without an operating permit to close until the FLOATATION TANK facility has obtained an operating permit.

7.2.2 Inspections

7.2.2.1 Preoperational Inspections

7.2.2.1.1 ***Terms of Operation*** The FLOATATION TANK facility may not be placed in operation until an inspection approved by the AHJ shows compliance with the requirements of this CODE or the AHJ approves opening for operation.

7.2.2.2 Exemptions

7.2.2.2.1 ***Applying for Exemption*** A FLOATATION TANK facility seeking an initial exemption or an existing FLOATATION TANK facility claiming to be exempt according to applicable regulations shall contact the AHJ for application details/forms.

7.2.2.2.2 ***Change in Exemption Status*** A FLOATATION TANK facility that sought and received an exemption from a public regulation shall contact the AHJ if the conditions upon which the exemption was granted change so as to eliminate the exemption status.

7.2.2.3 Variances

7.2.2.3.1 ***Variance Authority*** The AHJ may grant a variance to the requirements of this CODE.

7.2.2.3.2 ***Applying for a Variance*** A FLOATATION TANK facility seeking a variance shall apply in writing with the appropriate forms to the AHJ.

7.2.2.3.2.1 Application Components The application shall include, but not be limited to:

1) A citation of the CODE section to which the variance is requested;
2) A statement as to why the applicant is unable to comply with the CODE section to which the variance is requested;
3) The nature and duration of the variance requested;

4) A statement of how the intent of the CODE will be met and the reasons why the public health or SAFETY would not be jeopardized if the variance was granted; and

5) A full description of any policies, procedures, or equipment that the applicant proposes to use to rectify any potential increase in health or SAFETY risks created by granting the variance.

7.2.2.3.3 ***Revoked*** Each variance shall be revoked when the permit attached to it is revoked.

7.2.2.3.4 ***Not Transferable*** A variance shall not be transferable unless otherwise provided in writing at the time the variance is granted.

7.2.3 Operation and Maintenance

7.2.3.1 Preventive Maintenance Plan

7.2.3.1.1 Written Plan

7.2.3.1.1.1 Preventive Maintenance Plan Available A written comprehensive preventive maintenance plan for each FLOATATION TANK shall be available at the FLOATATION TANK facility.

7.2.3.1.1.2 Contents The FLOATATION TANK FACILITY preventive maintenance plan shall include details and frequency of owner/operator's planned routine facility inspection, maintenance, and replacement of recirculation and water treatment components.

7.2.3.1.2 Facility Documentation

7.2.3.1.2.1 Original Plans and Specifications Available A copy of the approved plans and specifications for each AQUATIC VENUE constructed after the adoption of this CODE shall be available at the FLOATATION TANK facility.

7.2.3.1.2.2 Equipment Inventory A comprehensive inventory of all mechanical equipment associated with each FLOATATION TANK shall be available at the AQUATIC FACILITY.

7.2.3.1.2.3 Inventory Details This inventory shall include:

1) Equipment name and model number;

2) Manufacturer and contact information;

3) Local vendor/supplier and technical representative, if applicable; and

4) Replacement or service dates and details.

7.2.3.1.2.4 Equipment Manuals Operation manuals for all mechanical equipment associated with each FLOATATION TANK shall be available at the FLOATATION TANK facility.

7.2.3.1.3.4.1 No Manual If no manufacturer's operation manual is available, then the FLOATATION TANK facility should create a written document that outlines STANDARD operating procedures for maintaining and operating the piece of equipment.

7.2.4 Ventilation

7.2.4.1 Purpose

AIR HANDLING SYSTEMS shall be maintained and operated by the owner/operator to protect the health and SAFETY of the facility's PATRONS.

7.2.4.2 Original Characteristics

AIR HANDLING SYSTEMS shall be maintained and operated to comply with all requirements of the original system design, construction, and installation.

7.2.5 Electrical Systems and Components

7.2.5.1 Electrical Repairs

7.2.5.1.1 Code Compliance Repairs or alterations to electrical equipment and associated equipment shall preserve compliance with the NEC and all applicable local, state, territorial, federal, and tribal laws. If there is a more than one applicable requirement then the most restrictive would apply.

7.2.5.1.2 Immediately Repaired All defects in the electrical system shall be immediately repaired.

7.2.5.1.3 Wiring Electrical wiring, whether permanent or temporary, shall comply with the NEC and all applicable local, state, territorial, federal, and tribal laws.

7.2.5.2 Electrical Receptacles

7.2.5.2.1 New Receptacles The installation of new electrical receptacles shall be subject to electrical-construction requirements of this CODE and all applicable local, state, territorial, federal, and tribal laws.

7.2.5.2.2 Repairs Repairs or maintenance to existing receptacles shall maintain compliance with the NEC and with 29 CFR 1910.304(b) (3) (ii).

7.2.5.2.3 Replacement Replacement receptacles shall be of the same type as the previous ones (e.g., grounding-type receptacles shall be replaced only by grounding-type receptacles), with all grounding conductors connected and proper wiring polarity preserved.

7.2.5.2.4 Substitutions Where the original type of receptacle is no longer available, a replacement and installation shall be in accordance with all applicable local, state, territorial, federal, and tribal laws.

7.2.5.3 Ground-Fault Circuit Interrupter

7.2.5.3.1 Manufacturer's Recommendations Where receptacles are required to be protected by GFCI devices, the GFCI devices shall be tested following the manufacturer's recommendations.

7.2.5.3.2 Testing Required GFCI devices shall be tested as part of scheduled maintenance on the first day of operation, and monthly thereafter, until the BODY OF WATER is drained and the equipment is prepared for STORAGE.

7.2.5.4 Grounding

7.2.5.4.1 Maintenance and Repair Maintenance or repair of electrical circuits or devices shall preserve grounding compliance with the NEC and all applicable local, state, territorial, federal, and tribal laws.

7.2.5.4.2 Grounding Conductors Grounding conductors that have been disconnected shall be re-inspected as required by the local building CODE authority prior to AQUATIC VENUE being used by BATHERS.

7.2.5.4.3 Damaged Conductors Damaged grounding conductors and grounding electrodes shall be repaired immediately.

7.2.5.4.4 Damaged Conductor Repair Damaged grounding conductors or grounding electrodes associated with recirculation or DISINFECTION equipment or with underwater lighting systems shall be repaired by a qualified person who has the proper and/or necessary skills, training, or credentials to carry out this task.

7.2.5.4.5 Public Access The public shall not have access to the FLOATATION TANK until such grounding conductors or grounding electrodes are repaired.

7.2.5.4.6 Venue Closure The FLOATATION TANK with damaged grounding conductors or grounding electrodes, that are associated with recirculation or DISINFECTION equipment or with underwater lighting systems, shall be closed until repairs are completed and inspected by the AHJ.

7.2.5.5 Bonding

7.2.5.5.1 Code Compliance Maintenance or repair of all metallic equipment, electrical circuits or devices, or reinforced concrete structures shall preserve bonding compliance with the NEC and with all applicable local, state, territorial, federal, and tribal laws.

7.2.5.5.2 Bonding Conductors Bonding conductors shall not be disconnected except where they will be immediately reconnected.

7.2.5.5.3 Disconnected Conductors The FLOATATION TANK shall not be used by BATHERS while bonding conductors are disconnected.

7.2.5.5.4 Removable Covers Removable covers protecting bonding conductors (e.g., at ladders), shall be kept in place except during bonding conductor inspections, repair, or replacement.

7.2.5.5.5 Scheduled Maintenance Bonding conductors, where accessible, shall be inspected semi-annually as part of scheduled maintenance.

7.2.5.5.6 Corrosion Bonding conductors and any associated clamps shall not be extensively corroded.

7.2.5.5.7 Continuity Continuity of the bonding system associated with RECIRCULATION SYSTEM or DISINFECTION equipment or with underwater lighting systems shall be inspected by the AHJ following installation and any major construction around the AQUATIC FACILITY.

7.2.5.6 Extension Cords

7.2.5.6.1 Temporary Cords and Connectors Temporary extension cords and power connectors shall not be used as a substitute for permanent wiring.

7.2.5.6.2 Minimum Distance from Water All parts of an extension cord shall be restrained at a minimum of 6 feet (1.8 m) away when measured along the shortest possible path from a BODY OF WATER during times when the FLOATATION TANK facility is open.

7.2.5.6.3 Exception An extension cord may be used within 6 feet (1.8 m) of the nearest edge of a BODY OF WATER if a permanent wall exists between the BODY OF WATER and the extension cord.

7.2.5.6.4 GFCI Protection The circuit supplying an extension cord shall be protected by a GFCI device when the extension cord is to be used within 6 feet (1.8 m) of a BODY OF WATER.

7.2.5.6.5 Code Compliance An extension cord incorporating a GFCI device may be used if that is acceptable under all applicable local, state, territorial, federal, and tribal laws.

7.2.5.6.6 Compliance The use of extension cords shall comply with 29 CFR 1910.304.

7.2.5.7 Portable Electric Devices Portable line-powered electrical devices, such as radios or drills, shall not be used within 6 feet (1.8 m) horizontally of the nearest inner edge of a BODY OF WATER, unless connected to a GFCI-protected circuit.

7.2.5.8 Communication Devices and Dispatch Systems The maintenance and repair of communication devices and dispatch systems shall preserve compliance with the NEC.

7.2.6 Plumbing

7.2.6.1 Water Supply

7.2.6.1.1 Water Pressure All plumbing shall be maintained in good repair with no leaks or discharge.

7.2.6.1.2 Cross-Connection Control Water introduced into the FLOATATION TANK, either directly or to the RECIRCULATION SYSTEM, shall be supplied through an air gap or by another method which will prevent BACKPRESSURE and back-siphonage.

7.2.6.2 Wastewater

7.2.6.2.1 Wastewater Disposal FLOATATION TANK wastewater/FLOATATION TANK SOLUTION, including backwash water and cartridge cleaning water, shall be disposed of in accordance with all applicable local, state, territorial, federal, and tribal laws.

7.2.6.2.2 Drainage Wastewater and backwash water shall not be returned to a FLOATATION TANK or the FLOATATION TANK facility's water treatment system.

7.2.6.2.3 Drain Line Filter backwash lines, DECK drains, and other drain lines connected to the FLOATATION TANK facility or the FLOATATION TANK facility RECIRCULATION SYSTEM shall be discharged through an approved air gap.

7.2.6.2.4 No Standing Water/Solution Discharge water/FLOATATION TANK SOLUTION shall not create any standing water/solution, a nuisance, offensive odors, stagnant wet areas, or an environment for the breeding of insects.

7.2.7 Solid Waste Management

7.2.7.1 Storage Receptacles

7.2.7.1.1 Good Repair and Clean Outside waste and recycling containers shall be maintained in good repair and clean condition.

7.2.7.1.2 Storage Areas Outside waste and recycling STORAGE areas shall be maintained in good repair and clean condition.

7.2.7.2 Disposal

7.2.8.2.1 Frequency Solid waste and recycled materials shall be removed at a frequency to prevent attracting vectors or causing odor.

7.2.8.2.2 Code Compliance Solid waste and recycled materials shall be disposed of in compliance with all applicable local, state, territorial, federal, and tribal laws.

7.2.8[A] Treatment System Required Operation Time

7.2.8.1 Turnover at Opening and Closing FLOATATION TANK filtration and DISINFECTION systems shall be operated for one volumetric TURNOVER before first use during the day and four volumetric TURNOVERS after the last PATRON at the end of the day; and

7.2.8.1.1 Turnovers Between Users For systems disinfected with Ozone or UV systems, a minimum of three volumetric TURNOVERS between users; or

7.2.8.2 Treatment Where FLOATATION TANK systems with external holding reservoirs are used to hold the FLOATATION TANK SOLUTION between PATRON use, all of the FLOATATION TANK SOLUTION must pass through the filtration and DISINFECTION systems before being returned to the FLOATATION TANK.

7.2.8.3 Controller The FLOATATION TANK system controller shall have the minimum length of filtration/DISINFECTION time to achieve three volumetric TURNOVERS built into the controller as a default.

7.2.8.3.1 Turnovers If the FLOATATION TANK controller does not have the capability of setting a default filtration time, the minimum filtration/DISINFECTION time required to achieve three volumetric TURNOVERS shall be posted adjacent to the controller.

7.2.9 Disinfection

7.2.9.1 3-log Inactivation Ozone and UV systems shall be operated and maintained to achieve the required design performance for a 3-log inactivation as specified in MAHC 7.1.8.2.

7.2.9.2 Operation Ozone and UV systems shall be operated and maintained in accordance with manufacturer's instructions.

7.2.9.3 Ozone Concentration Ozone DISINFECTION systems shall be operated and maintained so as to meet the ozone concentration output and not exceed the limits of off-gassed ozone in accordance with MAHC 7.1.8.3.

7.2.9.4 UV Calibrated Sensors

1) When UV is used, the UV sensors shall be calibrated at a frequency in accordance with manufacturer recommendations.
2) Records of calibration shall be maintained by the facility and available for review by the AHJ.

7.2.10 USP Grade Magnesium Sulfate Only USP grade magnesium sulfate shall be used in the FLOATATION TANK SOLUTION.

7.2.11 Cleansing Showers and Hygiene Facilities

7.2.11.1 Signage Signs or other comparable means of notification shall be provided instructing PATRONS to SHOWER before entering the FLOATATION TANK.

7.2.11.2 Cleaned and Sanitized HYGIENE FACILITY FIXTURES, CLEANSING SHOWERS, dressing area FIXTURES, and furniture shall be cleaned and SANITIZED daily, and more often if necessary, with an EPA– REGISTERED product, and more often if necessary, to provide a clean and sanitary environment.

7.2.11.3 Mold and Mildew HYGIENE FACILITY floors, walls, and ceilings shall be kept clean and free of visible mold and mildew.

7.2.11.4 Hand Wash Station HANDWASHING STATIONS shall include the following items:

1) Hand wash sink,
2) Adjacent soap with dispenser,
3) Hand drying device or paper towels and dispenser, and
4) Trash receptacle.

7.2.12[A] Cleaning

7.2.12.1 Daily Cleaning FLOATATION TANK interior surfaces at the waterline shall be scrubbed or wiped down on a daily basis to prevent build-up of slime and biofilm layers.

7.2.12.2 Weekly Cleaning FLOATATION TANK interior surfaces shall be scrubbed or wiped down on a weekly basis to prevent build-up of slime and biofilm layers.

7.2.12.3 Draining FLOATATION TANKS shall be drained and all interior surfaces shall be scrubbed or wiped down prior to refilling at a frequency necessary to prevent build-up of slime and biofilm layers.

7.2.13[A] Fecal/Vomit/Blood Contamination Response

7.2.13.1 Contamination Response Plan All AQUATIC FACILITIES with FLOATATION TANKS shall have a CONTAMINATION RESPONSE PLAN as specified in MAHC 6.5.1.

7.2.13.2 Floatation Tank Solution Contamination Response

7.2.13.2.1 Closure In the event of fecal or vomit contamination in a FLOATATION TANK, the AQUATIC FACILITY QUALIFIED OPERATOR shall immediately close the FLOATATION TANK to users until remediation procedures are complete.

7.2.13.2.2 Physical Removal Contaminating material shall be removed in accordance with MAHC 6.5.2.2.

7.2.13.3 Floatation Tank Solution Contamination Disinfection

7.2.13.3.1 Formed-Stool Contamination The filtration and DISINFECTION systems for formed- stool contaminated FLOATATION TANK SOLUTION shall be operated for the minimum volumetric TURNOVERS specified in MAHC 7.2.9. Operators may choose whether or not to treat as a diarrheal-stool or vomit concentration as in MAHC 7.2.13.3.2 to satisfy PATRON concerns.

7.2.13.3.2 Diarrheal-Stool or Vomit Contamination Diarrheal-stool contaminated float water shall be completely drained and the contaminated FLOATATION TANK surfaces disinfected prior to refilling as follows:

1) Empty FLOTATION TANK of all FLOTATION TANK solution, including all applicable equipment connected to the FLOATATION TANK (such as the pump, filter housing, UV light housing, etc..). If using a submersible pump to empty the FLOATATION TANK solution, ensure that the whole pump system, including the hose, has adequately been decontaminated by soaking in a bleach solution (1:10 dilution of fresh household bleach with water) for an excess of 20 minutes and re-flushing with fresh water.
2) Remove and dispose of the filter,
3) Spray the walls with a bleach solution and wipe down with disposable cleaning rags/wipes such as paper towels to remove as much remaining contamination as possible.
4) Fill the FLOATATION TANK to standard height with water. Do not add magnesium sulfate. Add CHLORINE (bleach) to FLOATATION TANK to provide 40 ppm of available free chlorine levels and ensure pH is 7.5 or lower and adjust if necessary. Verify and maintain water temperature at 77º F (25 C) or higher.
5) Run the pump without a filter for at least 30 minutes.
6) Empty the FLOATATION TANK of all bleach solution, including all applicable equipment connected to the floatation tank (such as the filter housing, UV light housing).
7) Refill the FLOTATION TANK and add a new filter, this time with magnesium sulfate, and add any other chemicals to return the FLOATATION TANK to normal operating levels.

7.2.13.3.3 Blood-Contamination The filtration and DISINFECTION systems for blood-contaminated FLOATATION TANK SOLUTION shall be operated for the minimum volumetric TURNOVERS specified in MAHC 7.2.9. Operators may choose whether or not to treat as a diarrheal-stool or vomit contamination as in MAHC 7.2.13.3.2 to satisfy PATRON concerns.

7.2.14 Operations

7.2.14.1 Operations Manual

7.2.14.1.1 Develop Each FLOATATION TANK facility shall develop an operations manual to keep at the FLOATATION TANK facility in both printed and electronic formats.

7.2.14.1.2 Include The manual shall at minimum include, but not be limited to the following items:

1) FLOATATION TANK description(s) and locations,
2) Facility communication,
3) List of chemicals and system information,
4) Fecal/vomit/blood CONTAMINATION RESPONSE PLANS,
5) Preventive maintenance plan, and

6) Any other STANDARD operation and maintenance policies and instructions or applicable information for each FLOATATION TANK at the facility.

7.2.14.2 Operation Records FLOATATION TANK facilities shall keep records pertaining to the operation, maintenance, and management of the FLOATATION TANK facility on a minimum schedule as prescribed under MAHC 7.2.15.3.

7.2.14.2.1 Records FLOATATION TANK facility records shall be:

1) Kept for a minimum of 3 years, and
2) Available upon request by the AHJ.

7.2.14.2.2 Additional Documentation Applicable local, state, territorial, federal, and tribal laws may require additional records, documentation, and forms.

7.2.14.3 Safety and Maintenance Inspection and Recordkeeping The QUALIFIED OPERATOR or RESPONSIBLE SUPERVISOR shall ensure that SAFETY and preventive maintenance inspections are done at the FLOATATION TANK facility during seasons or periods when the FLOATATION TANK facility is open and that the results are recorded in a log or form maintained at the FLOATATION TANK facility.

7.2.14.3.1 Daily Inspection Items The QUALIFIED OPERATOR or RESPONSIBLE SUPERVISOR shall ensure that a daily FLOATATION TANK facility preventive maintenance inspection is done before opening and that it shall include:

1) Drain covers, vacuum fitting covers, SKIMMER equalizer covers, and any other suction outlet covers are in place, secure, and unbroken;
2) SKIMMER baskets, weirs, lids, flow adjusters, and suction outlets are free of any blockage;
3) INLET and return covers and any other fittings are in place, secure, and unbroken;
4) Safety warning signs and other signage are in place and in good repair;
5) Entrapment prevention systems are operational;
6) Recirculation, DISINFECTION systems, controller(s), and probes are operating as required;
7) Underwater lights and other lighting are intact with no exposed wires or water in lights;
8) Slime and biofilm have been removed from accessible surfaces of FLOATATION TANKS;
9) Doors to nonpublic areas (CHEMICAL STORAGE SPACES, offices, etc.) are locked;
10) Fecal/vomit/blood incident CONTAMINATION RESPONSE PLANS, materials, and equipment are available;
11) Electrical devices are in good working condition and meet the requirements specified in the NEC and MAHC; and
12) Assessing FLOATATION TANK SOLUTION clarity such that the bottom and objects in the FLOATATION TANK are clearly visible.

7.2.14.3.2 Other Inspection Items The QUALIFIED OPERATOR or RESPONSIBLE SUPERVISOR shall ensure that the FLOATATION TANK facility preventive maintenance inspections shall also include:

1) Monthly tests of GFCI devices and
2) Inspections every 6 months of bonding conductors, where accessible.

7.2.14.4 Illness and Injury Incident Reports

7.2.14.4.1 Incidents to Record The owner/operator shall ensure that a record is made of all injuries and illness incidents at the FLOATATION TANK facility which:

1) Inactivation time (in hours) for 20 ppm DPD-FC Results in deaths;
2) Requires resuscitation, CPR, oxygen, or AED use;
3) Requires transportation of the PATRON to a medical facility; or
4) Is a PATRON illness or disease outbreak associated with FLOATATION TANK SOLUTION quality.

7.2.14.4.2 Info to Include Illness and injury incident report information shall include

1) Date,
2) Time,
3) Location,
4) Incident including type of illness or injury and cause or mechanism,
5) Names and addresses of the individuals involved,
6) Actions taken,
7) Equipment used, and
8) Outcome of the incident.

7.2.14.4.3 Notify the AHJ In addition to making such records, the owner/operator shall ensure that the AHJ is notified within 24 hours of the occurrence of an incident.

7.2.14.5 Bodily Fluids Remediation Log

7.2.14.5.1 Contamination Incidents A Body Fluid Contamination Response Log shall be maintained to document each occurrence of contamination of the FLOATATION TANK SOLUTION or its immediately adjacent areas by formed or diarrheal fecal material, whole stomach discharge of vomit, and blood.

7.2.14.5.2 Standard Operating Procedures The FLOATATION TANK facility's STANDARD operating procedures for responding to these contamination incidents shall be readily available for review by the AHJ.

7.2.14.5.3 Required Information The log shall include the following information recorded at the time of the incident:

1) Person conducting response;
2) Qualified operator or onsite responsible supervisor on duty;
3) Date and time of incident response;
4) Specific area, if not in the FLOATATION TANK SOLUTION, contaminated by incident;
5) Type and form of body fluid observed (for example, diarrheal or formed stool, vomit, or blood);
6) Date and time when the area was closed;
7) Remediation procedures used after the incident including contact time, if applicable; and
8) Date and time of reopening.

7.2.15 AHJ Inspections

7.2.15.1 Inspection Process

7.2.15.1.1 Inspection Authority The AHJ shall have the right to inspect or investigate the operation and management of a FLOATATION TANK facility.

7.2.15.1.2 Inspection Scope and Right Upon presenting proper identification, an authorized employee or agent of the AHJ shall have the right to and be permitted to enter any FLOATATION TANK facility or FLOATATION TANK area, including the recirculation equipment and piping area, at any reasonable time for the purpose of inspecting the FLOATATION TANK to do any of the following:

1) Inspect, investigate, or evaluate for compliance with this CODE;
2) Verify compliance with previously written violation orders;
3) Collect samples or specimens;
4) Examine, review, and copy relevant documents and records;
5) Obtain photographic or other evidence needed to enforce this CODE; or
6) Question any person.

7.2.15.1.2.1 Reasonable Time An authorized employee or agent of the AHJ shall not enter a room containing a FLOATATION TANK while the room or the tank is occupied by a customer.

7.2.15.1.3 Based on Risk A FLOATATION TANK facility's inspection frequency may be amended based on a risk of FLOATATION TANK SOLUTION injury and illness.

7.2.15.1.4 Inspection Interference It is a violation of this CODE for a person to interfere with, deny, or delay an inspection or investigation conducted by the AHJ.

7.2.15.2 Publication of Inspection Forms

7.2.15.2.1 Inspection Form Publication The AHJ may publish or post on the web or other source the reports of FLOATATION TANK facility inspections.

7.3 Artificial Swimming Lagoon (ASL) Design and Construction

These provisions address the design and construction requirements that are specific for artificial swimming lagoons. Unless addressed below, please refer to CDC's Model Aquatic Health Code Chapter 4 for guidance on the design and construction of typical public swimming pools and traditional aquatic venues. The CDC guidance for Artificial Swimming Lagoons does not intend to recommend use of any company specific or proprietary technology.

7.3.1 Design and Construction

7.3.1.1 Design and Construction ASLs will likely deviate from the required provisions for typical pools. Some AHJs might require a plan to be submitted and reviewed, or they might require variances. A plan review or variances might also be required for any substantial renovations to an ASL.

7.3.1.2 Plan Specifications Follow these ASL provisions, where they are not in conflict with AHJ requirements:

7.3.1.2.1 Variances ASL construction plans shall address health and safety concerns generated by variances.

7.3.1.2.2 Documentation Plans for building an ASL shall demonstrate, in the design and construction documentation, that an ASL is within the limits of sound engineering practice and achieves or exceeds the equivalent health and safety provisions required for pools.

7.3.1.2.2.1 Computational Fluid Dynamics Plans shall include computational fluid dynamics (CFD) analysis to document a positive hydraulic gradient from DSA(s) to the remainder of the ASL and the absence of dead zones in DSAs.

7.3.1.2.3 Certified Plans shall use equipment that are CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 or an approved alternative that meets or exceeds NSF standards.

7.3.1.2.3.1 Chemicals Only chemicals that are CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 and EPA REGISTERED for use in AQUATIC VENUES or SPAS in the United States shall be permitted.

7.3.1.2.4 Filters Filters and filter media shall be CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 by an ANSI-accredited certification organization, or approved alternative meeting or exceeding NSF standards.

7.3.1.2.4.1 Filter Performance Set a minimum performance goal for the ASL filters to remove at least 90% (1 log) of *Cryptosporidium* oocysts per single pass.

7.3.2 Technical Specifications

7.3.2.1 Peak Occupancy Peak occupancy for each DESIGNATED SWIMMING AREA (DSA) shall not to exceed the total (cumulative) surface area in square feet of the ASL's individual DSA, divided by the density factor (D) = 20ft2 (1.86m2) per BATHER.

7.3.2.2 Materials

7.3.2.2.1 Shell ASL construction shall incorporate a containment system using impervious material(s), which provides a smooth and SLIP-RESISTANT, easily cleaned, watertight structure capable of withstanding the anticipated stresses for full and empty conditions. Construction and design personnel shall take into consideration climatic, hydrostatic, and seismic conditions.

7.3.2.2.2 Prohibited Materials Wood, sand, or earth are not permitted as an interior finish.

7.3.2.2.3 Floors and Walls The floors and walls of the containment system shall be white or light pastel in color, such that the following items can be identified on the bottom: a person or body submerged in the water, algae growth, debris or dirt, and cracks in the surface finish.

7.3.2.2.3.1 Color Light pastel colors shall be consistent with a Munsell color value 6.5 or higher.

7.3.2.2.4 Visibility Design and construction shall assure that all points on the bottom of the ASL are visible in all areas, up to 30 feet (9.1 m) away in a direct line of slight.

7.3.2.3 Structure The design of the ASL shape shall provide for swimmer safety, assure easy cleaning and maintenance, and support effective supervision and surveillance of BATHERS and patrons.

7.3.2.3.1 Slope When Less Than 3 Feet For DSAs with water depths less than 3 feet (0.9 m), the slope of the floor shall not exceed 1 foot (30.5 cm) vertical drop for every 12 feet (3.7 m) horizontal.

7.3.2.3.2 Slope When Greater Than 3 Feet In water depths greater than 3 feet (0.9 m), the slope of the floor of the DSA shall not exceed 1 foot (30.5 cm) vertical drop for every 10 feet (3.3 m) horizontal.

7.3.2.3.3 Slope For Water Sports Area Outside of a DSA, the floor slope of an ASL shall not exceed 1 foot (30.5 cm) vertical drop for every 3 feet (0.9 m) horizontal.

7.3.2.4 Designated Swimming Area Boundaries

7.3.2.4.1 Shore DSAs can have a single shore entry, depending on design. The remaining border of the DSA will be outlined in the water, like a beach setting. The shore can serve as the only wet deck.

7.3.2.4.2 Water Boundaries For each DSA, mark designated boundaries in the water, or for any other aquatic feature accessible by BATHERS or patrons, with a ROPE AND FLOAT LINE or similar device(s) approved by the AHJ.

7.3.2.4.2.1 Rope and Float Line Rope line floats, or buoys, shall be at regular intervals no further than 25 feet (7.6 m) apart and where lines are joined.

7.3.2.4.4 Depth Markers Clearly visible depth marker buoys, or a similar device approved by the AHJ, are to be provided on the boundary float line and indicate the maximum depth within the DSA.

7.3.2.5 DSA Access and Egress

7.3.2.5.1 Access and Egress Where ZERO-DEPTH ENTRY is not used along the entire entrance of each DSA, there shall be at least two means of access and egress:

1) Stairs
2) Handrails
3) Grab Rails
4) Recessed Steps
5) Ladders
6) ZERO DEPTH ENTRIES

7.3.2.5.2 Wider Than 30 Feet For DSAs wider than 30 feet (9.1 m), such means of access/egress shall not be more than 75 feet (22.9 m) apart.

7.3.2.5.3 Accessibility Permanent or portable steps, ramps, handrails, lifts, or other devices designed to accommodate persons with disabilities must be provided as required by the Americans with Disabilities Act. Lifts mounted into the wet deck shall have a minimum 4-foot-wide walkway behind the mount, on the shore or deck behind the lift. Compliance with the Americans with Disabilities Act might require multiple means of access/egress for those with disabilities.

7.3.2.5.4 Water Sports Area The rules for swimming access and egress do not apply outside of DSAs, in the water sports area of the ASL.

7.3.2.5.5 Trench Drains Trench drains are not required along zero depth entries at the waterline.

7.3.2.6 DSA Zero Depth Entries

7.3.2.6.1 Slip-Resistant Where ZERO DEPTH ENTRIES are provided, they shall be constructed with SLIP-RESISTANT materials.

7.3.2.6.2 Floor Slope The floor slope for ZERO DEPTH ENTRIES shall have a maximum grade that does not exceed 1 foot (30.5 cm) vertical drop for every 12 feet (3.7 m) horizontal. The floor slope does not need to be consistent throughout the DSA. Variability in floor slope(s) is acceptable, as long as the 1:12 ratio is not exceeded.

7.3.2.6.3 Deck Entry Area ZERO DEPTH ENTRY deck areas shall slope toward the water for no more than 7 feet (2.133 m), as measured from the water's edge outward (away from the water). Beyond 7 feet from the waterline, the deck or other surfaces shall slope away from the lagoon at a minimum of 1:50 ratio to a maximum of 1:25 ratio.

7.3.2.6.3.1 Extension From Waterline ZERO-DEPTH ENTRY decks shall be extended out at least 4 feet from the edge of the waterline.

7.3.2.6.4 ***Docks*** Docks for aquatic activities such as sailing or kayaking, located outside of DSAs, are exempt from guidance for ZERO DEPTH ENTRIES.

7.3.2.7 DSA Depth Markers and Markings

7.3.2.7.1 ***Depth Markers*** Where applicable, depth markers are recommended on the inside vertical walls of a DSA. These markers or signs are required only along the accessible perimeter of the DSA.

7.3.2.7.2 ***Signage*** Signage may be substituted for markers if approved by the AHJ.

7.3.2.7.3 ***Markings*** Markings shall be made of materials that will not fade over time.

7.3.2.7.4 ***No Diving*** Signs and markers shall incorporate the following:

7.3.2.7.4.1 At Access Points Depth markers shall be secured on a sign at access points indicating the deepest point in the DSA.

7.3.2.7.4.2 Vertical Walls Install NO DIVING markers where access to a portion of the DSA with a vertical wall is not blocked or obstructed by an approved enclosure or barrier.

7.3.2.7.4.3 5 Feet or Less For water depths 5 feet (1.5 m) or shallower, all depth markers shall have warning signs with the words NO DIVING, along with the universal international symbol for NO DIVING.

7.3.2.7.4.4 Sign Spacing Space NO DIVING warning signs and symbols at no more than 25-foot (7.6 m) intervals around the DSA perimeter edge.

7.3.2.7.4.5 Durable Material NO DIVING markers shall be constructed of a durable material resistant to local weather conditions.

7.3.2.7.4.6 Size All NO DIVING lettering and symbols shall be at least 4 inches (10.2 cm) in height.

7.3.2.8 DSA Recirculation and Water Treatment

7.3.2.8.1 ***For Each Designated Swimming Area*** Operators shall ensure the ASL recirculation and filtration system provides circulation, filtration, skimming, and DISINFECTION of the water to maintain the jurisdiction's requirements for pool water quality and clarity in each DSA.

7.3.2.8.2 ***Variances*** Alternatives to the design and operational pool requirements are allowed in ASL, when approved by the AHJ. The design professional must provide a rationale and include a CFD analysis.

7.3.2.8.3 ***Alternate Designs*** Alternate and various designs for introduction of treated water into DSAs require supporting documentation demonstrating an ability to maintain all DSA water quality parameters.

7.3.2.8.4 ***Water Replacement*** TURNOVER TIME concepts for typical pools do not apply to ASLs overall. Operators shall ensure that water in each DSA is replaced at a renewal rate of 6 hours or less.

7.3.2.8.5 ***Positive Hydraulic Gradient*** When DSAs are open for BATHERS, an operator shall maintain a positive hydraulic gradient. Using CFD or other means, the design professional shall ensure the volumetric replacement of water in each DSA occurs every 6 hours or less.

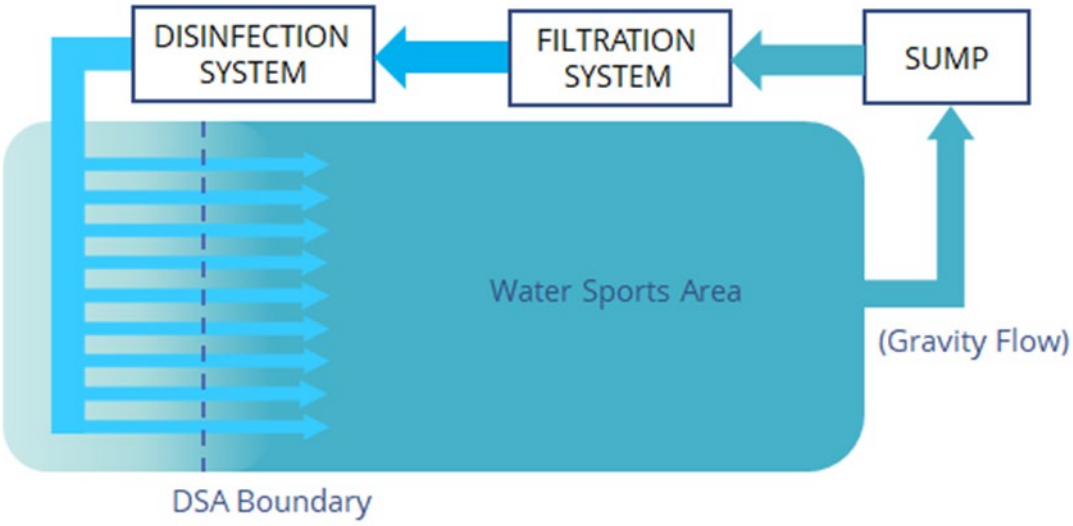
7.3.2.8.6 ***Continuous Operation*** Maintain replacement DSA water through the continuous operation (24/7) of the RECIRCULATION SYSTEM and flow direction of INLET nozzles.

7.3.2.8.7 ***Recirculation*** RECIRCULATION and DISINFECTION systems shall be able to treat water either under gravity feed or via a pressure system as justified by the design professional. Operators shall ensure that

water for the DSA is pulled into the filtration and DISINFECTION system, then returns to the DSA and displaces water into the water sports area (Figure 7.3.2.8.6.1).

Figure 7.3.2.8.6.1: Example ASL Water Flow Schematic

Image courtesy of Crystal Lagoons



7.3.2.9 ASL Water Supply

7.3.2.9.1 Source Water Water serving an ASL shall be supplied from a potable water source or other source approved by the AHJ. Salt electrolytic CHLORINE generation is permitted.

7.3.2.9.2 Alternate Designs Alternate and various designs for introduction of treated water into the Water Sports Area can be approved by the AHJ, with supporting documentation that includes CFD analysis demonstrating that water from the Water Sports Area does not flow back against the positive pressure gradient of any DSA.

7.3.2.9.3 External Pollution If an external pollution source that is affecting the water quality of the lagoon is identified, the entire ASL is to be immediately closed for use. Prior to re-opening, the source shall be eliminated, and all water remediated and tested for compliance with quality parameters.

7.3.2.10 ASL Wastewater

7.3.2.10.1 Wastewater Re-Use Wastewater from an ASL, including filter backwash water, can be reused in the ASL, if discharged into the water sports area(s) and not directly into DSAs (at least 50 feet (15.2 m) from a DSA boundary).

7.3.2.10.1.1 Backwater Re-Use If backwash water is to be re-used, it first is to be:

1) Released to a sedimentation tank with flocculant and allowed to settle,
2) Re-filtered, and
3) Disinfected so that DPD-FC concentration of re-use backwash water is a minimum of 1.0 ppm (mg/L).

7.3.2.10.2 Discharge Wastewater can be discharged to a sanitary sewer system having sufficient capacity to collect and treat wastewater, or to an on-site disposal system designed for this purpose.

7.3.2.11 Decks and Equipment

7.3.2.11.1 Deck Width Shoreline decks are to extend out at least 4 feet (1.2 m) from the edge of the waterline.

7.3.2.11.2 Rope and Float Line Decks are not applicable for the water borders or boundaries (ROPE AND FLOAT LINE) of a DSA.

7.3.2.11.3 Islands

7.3.2.11.3.1 Bather Traffic An ISLAND that is designed for BATHER traffic can be accessible by a ZERO-DEPTH ENTRY.

7.3.2.11.3.2 Island Decks DECK requirements for a pool are not applicable to an ISLAND within an ASL.

7.3.2.11.3.3 Island Signage Depth markings and warning signs for ISLANDS shall be consistent, as listed above.

7.3.2.11.4 Limited Entry Each DSA shall have a means to limit entry into the deck and beach area, to deter (barrier) and prevent (enclosure) unauthorized entry. A self-closing and self-latching gate shall be used for access to each DSA beach area.

7.3.2.11.5 Water Sports Area Barriers and Enclosures Barriers or enclosures are not needed immediately adjacent to the water sports area.

7.3.2.11.6 Water Sports Area Deck Decks are not needed adjacent to the water sports area.

7.3.2.12 Hygiene Facilities HYGIENE FACILITIES and HYGIENE FIXTURES shall be provided.

7.3.2.12.1 Minimum Number The minimum number, types, and locations of HYGIENE FACILITIES will be based on the PEAK OCCUPANCY of each DSA as described above. For the water sports area, the minimum number, types, and locations of HYGIENE FACILITIES will be based on the AHJ's requirements for ambient or natural water bodies.

7.4 Artificial Swimming Lagoon Operation and Management

These provisions address the operation and management requirements that are specific for artificial swimming lagoons. Unless addressed below, please refer to CDC's Model Aquatic Health Code Chapters 5 and 6 for guidance on the operation and management of typical public swimming pools and traditional aquatic venues. The CDC guidance for Artificial Swimming Lagoons does not intend to recommend use of any company specific or proprietary technology.

7.4.1 Operations

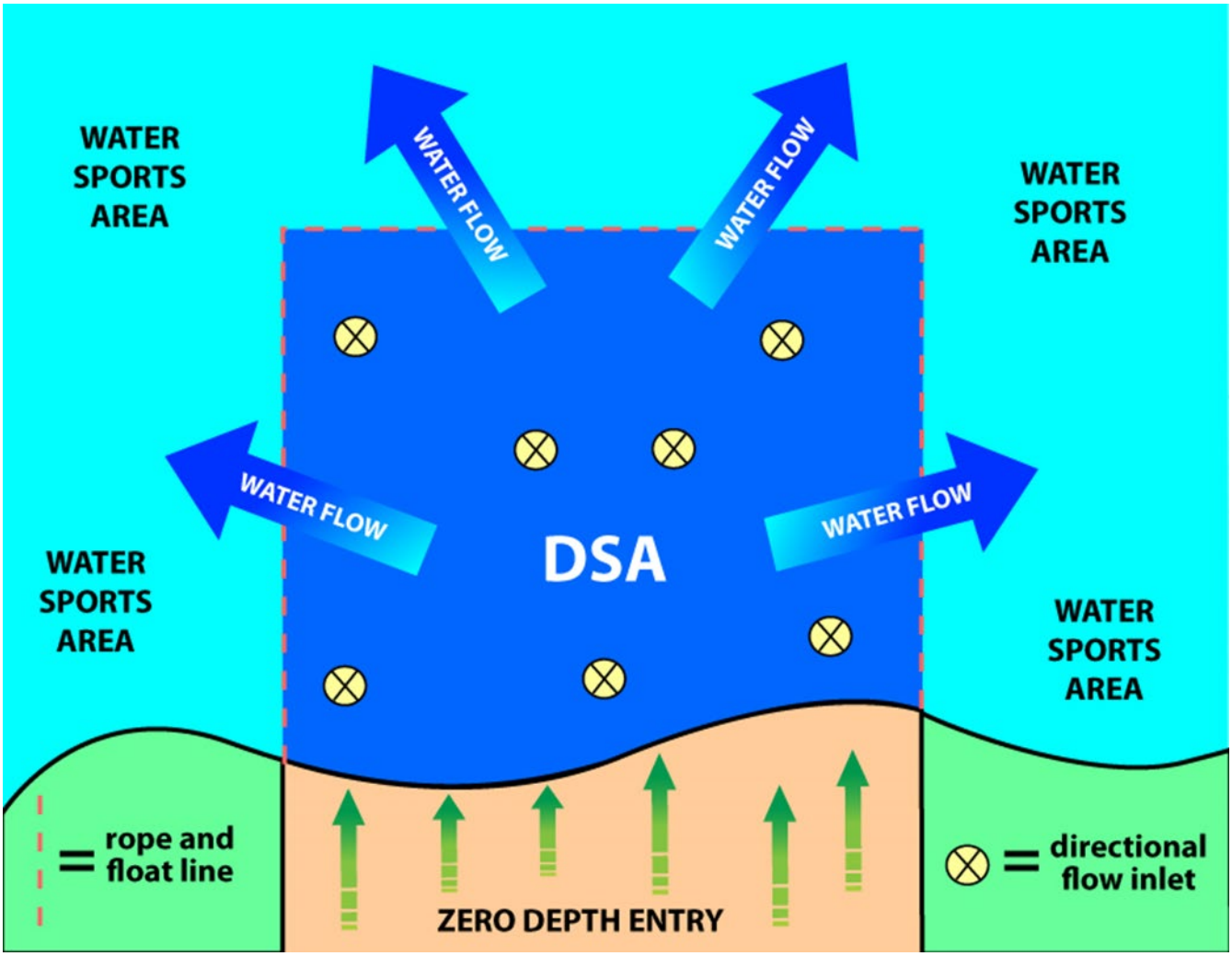
7.4.1.1 Operation Swimming in a DSA shall only be allowed when operators are able to maintain the positive pressure gradient of treated water flowing into and displacing potentially contaminated water out of the DSA (Figure 7.4.1.1.1).

7.4.1.2 Cease of Operations When an ASL is permanently shut down, owner/operators need to ensure that the enclosure restricts all unauthorized entry to the property from the public.

7.4.1.2.1 Decommissioning Owner/Operators shall work with the AHJ to develop a plan for decommissioning or draining all water from the entire ASL.

7.4.1.2.1.1 Draining When draining is not allowed due to discharge and flooding concerns, the owner/operator shall determine whether the water can be re-purposed.

Figure 7.4.1.1.1: Example Designated Swimming Area Water Flow Schematic



7.4.2 Water Quality

7.4.2.1 DSA Parameters When the area is open for BATHERS, water quality in the DSA shall always meet the criteria in Table 7.4.2.1.1.

Table 7.4.2.1.1: Water Quality in Designated Swimming Areas

Parameter	Value
DPD-FC	≥ 1.0 ppm (mg/L)
Bromine	3.0–8 ppm (mg/L)
CYA*	≤ 15 ppm
pH	7.0–7.8
Turbidity	≤0.5 NTU

*If a stabilizer is used, this concentration allows for immediate response to fecal incidents based on CYA guidelines found in CDC's MAHC 6.5 Fecal/Vomit/Blood Contamination Response.

7.4.2.1.1 Water Sports Area Requirements for water quality parameters in Table 7.4.2.1.1 are not applicable for the water sports area.

7.4.2.2 Water Clarity

7.4.2.2.1 Water Sports Area Outside of a DSA, the water shall be maintained such that the bottom is visible while the water is static, so that all points on the bottom of the ASL are visible in all areas, up to 30 feet (9.1 m) away in a direct line of slight.

7.4.2.2.2 Remote Monitoring Monitoring turbidity remotely shall use an online turbidimeter that is CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50 that can measure influent clarity.

7.4.2.2.3 When Closed When a facility is closed and not in use (such as during the off season), clarity shall be maintained in all DSAs at ≤0.5 nephelometric turbidity units (NTU). When not in use, clarity in the Water Sports Area shall be continuously maintained such that the bottom is visible while the water is static.

7.4.2.2.4 Manual Evaluation If turbidity is evaluated manually, then the following criteria shall be met:

7.4.2.2.4.1 10 Feet or Less In DSAs with a water depth of 10 feet or less, the water clarity is to be maintained so that a 4-inch by 4-inch (10.2 cm x 10.2 cm) black square, Secchi Disk, or marker tile of contrasting color, is visible on the floor at the deepest part of the DSA. The marker tile shall be clearly and immediately seen by an observer on the water surface above the marker or at any point on the shore/deck up to 30 feet (9.1m) away in a direct line of sight from the tile.

7.4.2.2.4.2 Greater Than 10 Feet For DSAs over 10 feet (3.0 m) deep, the water clarity is to be maintained so that an 8-inch by 8-inch (20.3 x 20.3 cm) black square, Secchi Disk, or marker tile of contrasting color, is visible on the floor at the deepest part of the DSA. The marker tile shall be clearly and immediately seen by an observer on the water surface above the marker or at any point on the shore/deck up to 30 feet (9.1m) away in a direct line of sight from the tile.

7.4.2.3 Testing Equipment

7.4.2.3.1 Each DSA Water quality is to be monitored and controlled in each DSA using a water chemistry control system that is CERTIFIED, LISTED, AND LABELED to NSF/ANSI 50. Consider using real-time remote communications and alert notification capabilities.

7.4.2.3.2 Remote Monitoring If remote chemical monitoring sensors are used, at least one chemical sensor shall be installed in each DSA, in addition to waterside manual testing. Remote systems can be used to aid the monitoring of ASLs and DSAs, but shall not be used as a substitute for on-site operation and maintenance.

7.4.2.3.3 Algae Growth Algae growth, particularly on the venue floor, is to be prevented in both the DSAs and the water sports area.

7.4.2.3.4 Periods of Non-Use During non-use, water shall be maintained so as not to become contaminated and harmful, or capable of producing unpleasant odors or insect breeding areas.

7.4.2.4 Water Testing Plans

7.4.2.4.1 Designated Swimming Areas Measurements for sanitizer concentration (free available CHLORINE or bromine) and pH shall be taken each day prior to opening to BATHERS in each DSA.

7.4.2.4.1.1 Prior To Use The operator will ensure that the sanitizer concentration and pH are in the proper range before allowing BATHERS into the water.

7.4.2.4.1.2 Twice Daily Additional tests for sanitizer levels and pH are to be conducted at least two times a day in each DSA.

7.4.2.4.2[A] Water Sports Area Water in the water sports area is quite different than natural lakes, rivers, and beaches. This constructed environment will not allow aquatic wildlife habitation, nor will it contain a natural sediment/bottom with aquatic plants. Contamination detected through fecal indicator

bacteria monitoring could be human or animal. However, contamination risks are much different in an ASL than in other natural waters with non-human fecal inputs like lakes and beaches.

7.4.2.5 Microbial Water Quality Monitoring in Water Sports Area

7.4.2.5.1 Water Sports Area ASL operators shall develop a microbial water quality monitoring plan for the water sports area and establish minimum microbiological indicators in the ASL water sports area when open to the public.

7.4.2.5.1.2 Designated Swimming Areas Microbial water quality testing is not recommended in treated DSAs, unless a DSA is suspected of being associated with an outbreak.

7.4.2.5.2 Lower Than Natural Waters Microbial numbers in the water sports area could be expected to be lower than natural waters because of the built-environment and recent treatment in the DSA.

7.4.2.5.3[A] Refer to Established Methods Refer to local, state, territorial, and tribal laws for recreational water quality standards for natural bodies of water. Jurisdictions might already have guidance on how to address water quality indicators for freshwater lakes, rivers, and beaches with recreational water access.

7.4.2.5.4 Natural Water Body Monitoring In the absence of scientific data, natural water body monitoring plans could be applied to microbial monitoring in the water sports area.

7.4.2.5.5 EPA Resources The U.S. Environmental Protection Agency (EPA) has resources on developing site-specific water monitoring plans for non-primary contact (e.g., canoeing, kayaking) that are based on potential fecal sources (e.g., human, bird, racoon, dog). EPA also has published recommendations for monitoring freshwater beaches for safe recreational use.

7.4.2.6 Artificial Swimming Lagoon Safety Standards

7.4.2.6.1 Night Swimming Swimming at night in DSAs is prohibited.

7.4.2.6.2 Powered Watercraft Watercrafts powered by internal combustion engines are prohibited.

7.4.2.6.3 Vacuum Systems Operation of vacuum systems in a DSA is prohibited while the area is open for swimming.

7.4.2.6.4 Supervision QUALIFIED LIFEGUARD supervision is required in each DSA.

7.4.2.6.4.1 Qualified Lifeguards Additional QUALIFIED LIFEGUARD(S) recommendations for DSAs can be found in the MAHC, chapter 6.3.2 (Aquatic Facilities Requiring QUALIFIED LIFEGUARDS).

7.4.2.6.5 Personal Floatation Devices U.S. Coast Guard-approved personal floatation devices or life jackets are to be provided to participants, and required to be worn in the water sports area.

7.4.2.6.5.1 Personal Floatation Devices for Minors Refer to local, state, territorial, and tribal laws for requirements on the use of personal floatation devices for minors while on watercrafts in the water sports area.

7.4.2.6.6 Additional Equipment Additional QUALIFIED LIFEGUARD(S) and safety equipment recommendations for DSAs can be found in the MAHC, chapter 5.8.5 (Lifeguard and Safety-related Equipment).

7.4.3 Fecal Incident Response

7.4.3.1 Formed-Stool Contamination in a DSA

7.4.3.1.1 Designated Swimming Areas Have all BATHERS leave the DSA immediately.

7.4.3.1.2 Remove Stool Remove the formed/solid stool from the swimming area with a net and proper PPE.

7.4.3.1.3 DPD-FC Concentration Ensure that DPD-FC concentration of water exiting the INLET nozzles is a minimum of 2.0 ppm (mg/L).

7.4.3.1.3.1 Chemical Adjustments Make necessary chemical adjustments through use of the directional floor INLETS in the contaminated DSA.

7.4.3.1.4 Keep Bathers Out Keep all BATHERS out of the contaminated DSA for at least an additional 60 minutes, before allowing re-entry.

7.4.3.2 Diarrheal-Stool Contamination in a DSA

7.4.3.2.1 Designated Swimming Areas Have all BATHERS leave the DSA immediately.

7.4.3.2.2 DPD-FC Concentration Ensure that DPD-FC concentration of water exiting the INLET nozzles is a minimum of 20.0 ppm (mg/L).

7.4.3.2.2.1 Chemical Adjustments Make necessary chemical adjustments through use of the directional floor INLETS in the contaminated DSA.

7.4.3.2.3 Keep Bathers Out Keep all BATHERS out of contaminated the DSA for at least an additional 6 hours, before allowing re-entry.

7.4.3.2.3.1 Water Displacement Or keep all BATHERS out of the contaminated DSA for enough time until a complete water replenishment/displacement cycle of DSA water has occurred, as demonstrated by CFD.

2024 Annex to the Model Aquatic Health Code

Scientific Rationale

5th Edition, December 2024

CS349805-A

Annex to the 2024 Model Aquatic Health Code, 5th Edition

SCIENTIFIC AND BEST PRACTICES RATIONALE

Posted on 12/16/2024

This information is distributed solely as guidance for the purpose of assisting local, state, territorial, and tribal public health agencies; aquatic facility inspection programs; the aquatics sector; building officials; and other parties to promote public health at public aquatic facilities. This document does not address all public health concerns associated with public aquatic facility use. It is the responsibility of the user of this document to establish appropriate public health practices and determine the applicability of regulatory limitations prior to each use.

Foreword

Swimming, relaxing, and playing in water have been global pastimes throughout written history. Twentieth-century advances in aquatics—combining disinfection, filtration, and recirculation systems—led to an explosion in the use of residential and public aquatic venues (e.g., pools, hot tubs, and water playgrounds). As residential and public pool use has swept across the United States, leisure time with family and friends in and around the pool has increased. Advances in public aquatic facility design have pushed the horizons of aquatic facilities from the traditional rectangular community pool to the multi-venue waterpark hosting tens of thousands of users per day. Indoor public aquatic facilities have transformed pools and waterparks into year-round attractions. At the same time, research has demonstrated the physical and psychosocial benefits of aquatics for all age groups.

However, these aquatics sector changes—combined with changes in the general population, emergence of pathogens protected from chlorine, and imperfect bather hygiene—have resulted in substantial increases in the number of reports of recreational water–associated outbreaks. This increase is driven by the substantial increase in the number of outbreaks associated with public aquatic venues and caused by *Cryptosporidium*. Drowning continues to claim the lives of far too many, particularly young children. Thousands of people visit U.S. emergency departments every year for pool chemical injuries. Public aquatic facility operation can be improved through engineering, education, and enforcement.(1) The increase in the number of reported outbreaks and the continued occurrence of drowning and other injuries suggest the prevention of public aquatic venue–associated illness, injury, disability, and death would benefit from building stronger environmental health regulatory programs and supporting them with strong partnerships. It also would be useful for public health officials to continue to play their strong role in overseeing design and construction, advising on operation and maintenance, and helping inform policy and management. Working in close collaboration with building code officials strengthens the overall coordination needed to prioritize public health at public aquatic facilities.

The 5th Edition of the Model Aquatic Health Code (MAHC) is the latest effort to improve the MAHC, which is a set of voluntary guidance based on science and best practices. The MAHC was developed to help programs that regulate public aquatic facilities reduce the risk of illness, injury, disability, and death in their communities (see MAHC history at https://www.cdc.gov/model-aquatic-health-code/php/about/creating-the-mahc.html). The MAHC is a leap forward from U.S. Centers for Disease Control and Prevention's (CDC) operational and technical manuals published in 1959, 1976, and 1981 and a logical progression of CDC's Healthy Swimming program, which was started in 2001. The 2024 MAHC (5th Edition) underscores CDC's long-term involvement and commitment to improving aquatic health and safety. MAHC guidance stemmed from concern about the substantially increasing number of reported outbreaks starting in the mid-1990s. Creation of the MAHC was the major recommendation of a 2005 national workshop, which was charged with developing recommendations to reduce the incidence of these outbreaks. Local, state, and federal public health officials and the aquatics sector formed an unprecedented 7-year collaboration to create the 2014 MAHC (1st Edition). The MAHC is being regularly updated with input from the Council for the Model Aquatic Health Code (CMAHC). The CMAHC was established to help CDC keep the MAHC up to date and current with the latest advances in the aquatics sector while also responding to the latest public health reports of public aquatic venue–associated illness, injury, disability, and death. For each update cycle, CMAHC leads efforts to solicit, collect, and assess MAHC change requests (proposed changes to improve the MAHC); hosts a national stakeholder conference to discuss change requests; and holds a membership vote on the proposed changes. The partnership among public health, the aquatics sector, the CMAHC, and academia strengthens the efforts to achieve CDC's vision of "healthy and safe aquatic experiences for everyone."

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1.0 Glossary of Abbreviations

AAU	Amateur Athletic Union
ACA	American Coatings Association
ACCA	Air Conditioning Contractors of America
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidance
AED	Automated External Defibrillator
AHA	American Heart Association
AHJ	Authority Having Jurisdiction
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
APSP	Association of Pool and Spa Professionals
ARC	American Red Cross
ASHI	American Safety & Health Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
ATSDR	United States Agency for Toxic Substances and Disease Registry
BCDMH	1-bromo-3-chloro-5, 5-dimethylhydantoin
BVM	Bag-Valve Mask
CCPRF	Citizen CPR Foundation
CDC	United States Centers for Disease Control and Prevention
CEL	Certified Equipment List
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEU	Continuing Education Units
CFM	Cubic Feet Per Minute
CFOC	Caring for Our Children
CFP	Conference for Food Protection
CFR	Code of Federal Regulations
CI	Chlorine Institute
CMAHC	The Council for the Model Aquatic Health Code
CoSTR	Consensus on Science and Treatment Recommendations
CPR	Cardiopulmonary Resuscitation
CPSC	United States Consumer Product Safety Commission
CSA	Canadian Standards Association
CYA	Cyanuric Acid

DBDMH	Dibromodimethylhydantoin
DBP	Disinfection Byproduct
DCOF	Dynamic Coefficient of Friction
EAP	Emergency Action Plan
ECC	Emergency Cardiovascular Care
ECCU	Emergency Cardiovascular Care Update
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FAC	Free Available Chlorine
FDA	United States Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FPM	Feet Per Minute
GFCI	Ground-Fault Circuit Interrupter
GPM	Gallons Per Minute
HazCom	Hazard Communication Standard
HMIS	Hazardous Material Identification System
HOBr	Hypobromous Acid
HOCl	Hypochlorous Acid
HSC	California Health and Safety Code
HSEESS	Hazardous Substance Emergency Events Surveillance System
HVAC	Heating, Ventilation, and Air Conditioning
IAEI	International Association of Electrical Inspectors
IAF	International Aquatic Foundation
IAPMO	International Association of Plumbing and Mechanical Officials
IARC	International Agency for Research on Cancer
IBC	International Building Code
ICBO	International Council of Building Officials
ICC	International Code Council
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
ILCOR	International Liaison Committee on Resuscitation
IMC	International Mechanical Code
IPC	International Plumbing Code
ISEA	International Safety Equipment Association
ISO	International Organization for Standardization
ISPSC	International Swimming Pool and Spa Code

MAHC	Model Aquatic Health Code
MERV	Minimum Efficiency Reporting Value
METS	Metabolic Equivalents
MRC	Moisture Removal Capacity
MRE	Moisture Removal Efficiency
MSBL	Maximum Sustainable Bather Load
NCAA	National Collegiate Athletic Association
NEC	National Electrical Code
NEHA	National Environmental Health Association
NEISS	National Electrical Injury Surveillance System
NEMA	National Electrical Manufacturers Association
NFHS	National Federation of State High School Associations
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NPDS	National Poison Data System
NPSH	Net Positive Suction Head
NRPA	National Recreation and Park Association
NRR	Noise Reduction Ratings
NRTL	Nationally Recognized Testing Laboratory
NSF	NSF International (formerly National Sanitation Foundation)
NSPF	National Swimming Pool Foundation
OEM	Original Equipment Manufacturer
ÖNORM	Österreichisches Normungsinstitut (Austrian Standards Institute)
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PERC	Propane Education and Research Council
PHMB	Polyhexamethylene Biguanide Hydrochloride
PMRA	Health Canada Pest Management Regulatory Agency
PPE	Personal Protective Equipment
PPM	Parts Per Million
PVC	Polyvinyl Chloride
PVC-P	Plasticized Polyvinyl Chloride
PWTAG	Pool Water Treatment Advisory Group
RED	Reduction Equivalent Dose
RLV	Relative Limit Value

RP	Reduced Pressure Principle Assembly
RPZ	Reduced Pressure Zone
RWI	Recreational Water–Associated Illness
SCBA	Self-Contained Breathing Apparatus
SCI	Spinal Cord Injury
SDS	Safety Data Sheet
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SOFAs	Submerged Suction Outlets Fitting Assemblies
STC	Sound Transmission Class
SVRS	Safety Vacuum Release System
TB	Total Bromine
TDH	Total Dynamic Head
TDS	Total Dissolved Solids
THM	Trihalomethane
TLV	Threshold Limit Value
UL	Underwriters Laboratories
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
USACE	United States Army Corps of Engineers
USC	United States Code
USDOE	United States Department of Energy
USLSC	United States Lifeguarding Standards Coalition
USPSHTC	Uniform Swimming Pool, Spa, and Hot Tub Code
UV	Ultraviolet
UVT	Ultraviolet Transmittance
VFD	Variable Frequency Drive
VGB Act	Virginia Graeme Baker Pool and Spa Safety Act
WC	Water Closet
WHO	World Health Organization
WQTD	Water Quality Testing Device
YMCA	Young Men’s Christian Association

2.0 Glossary of Terms

"Accessible Route" means access/egress standards as defined by 2010 ADA Standards for Accessible Design.

"Activity Pool" *See "Pool."*

"Air Delivery Rate" means the supply cfm of the air handler system*(s)* comprised of a combination of outside air and return air minus any exhaust air if exhausted within the air handler itself.

"Air Handling System" means equipment that brings in outdoor air into a building and removes air from a building for the purpose of introducing air with fewer contaminants and removing air with contaminants created while bathers are using aquatic venues. The system contains components that move and condition the air for temperature, humidity, and pressure control, and transport and distribute the air to prevent condensation, corrosion, and stratification, provide acceptable indoor air quality, and deliver outside air to the breathing zone.

"Agitated Water" *See "Theoretical Peak Occupancy."*

"Alpha Bar" *See "Average Sound Absorption Coefficient."*

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

"Aquatic Facility or Aquatic Venue Enclosure" means an enclosure, as defined herein, that surrounds and secures an aquatic facility or aquatic venue.

"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.

- **"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 ages less than 5 years)* 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 ages less than 5 years as well as therapy pools.
- **"Lazy River"** means a channeled flow of water of near−constant depth in which the water is moved by pumps or other means of propulsion to provide a river−like flow that transports bathers over a defined path. A lazy river may include play features and devices. A lazy river may also be referred to as a tubing pool, leisure river, leisure pool or a current channel.
- **"Spa"** means a structure intended for either warm or cold water where prolonged exposure is not intended. Spa structures are intended to be used for bathing or other recreational uses and are not usually drained and refilled after each use. It may include, but is not limited to, hydrotherapy, air induction bubbles, and recirculation.
- **"Special Use Aquatic Venue"** means aquatic venues that do not meet the intended use and design features of any other aquatic venue or pool listed/identified in this Code.

"Artificial Swimming Lagoon" (ASL) means a large format aquatic venue. The ASL is designed to mimic a natural water body and consists of one or more designated swimming areas with the remainder of the lagoon

designated for water sports and non-traditional uses, including: Kayaking, Paddle-boarding, Windsurfing, Boating, and SCUBA diving training,

"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, installations, or procedures.

"Automated Controller" means a system of at least one chemical probe, a controller, and auxiliary or integrated component that senses the concentration of one or more water parameters and provides a signal to other equipment to maintain the parameters within a user-established range.

"Available Chlorine" *See "Chlorine."*

"Average Sound Absorption Coefficient" *(Alpha Bar)* means the weighted average sound absorption coefficient for a room calculated by weighting the sound absorption coefficients of the individual surfaces in the room according to their respective areas and taking the arithmetic average as follows *(especially in the 500 Hz and 1,000 Hz frequencies)*: And m^2 *(or ft^2)*; where areas of the individual sound absorptive surfaces, m^2 *(or ft^2)* respective individual absorption coefficients *(dimensionless)*. A sound absorption coefficient is of a surface, in a specified frequency band, the fraction of the randomly incident sound power which is absorbed *(or otherwise not reflected)* by a material metric: sabin/m^2.

"Backflow" means the undesirable reversal of flow of water or other substances through a cross-connection and into the piping of the source water system. There are two types of backflow: backpressure and backsiphonage.

"Background Noise" means noise from all sources unrelated to a particular sound that is the object of interest. Background noise may include airborne, structure borne and instrument noise.

"Backpressure" means a type of backflow where the hydraulic condition, caused by a difference in water pressure, causes an undesirable reversal of the flow as a result of a higher water pressure in the system than in its supply.

"Backsiphonage" means a type of backflow where the reversal of flow of water is due to a drop in pressure of the supply in the source water system**.**

"Barrier" means an obstacle intended to deter direct access from one point to another.

"Bather" means a person at an aquatic venue who has contact with water either through spray or partial or total immersion. The term bather as defined, also includes staff members, and refers to those users who can be exposed to contaminated water as well as potentially contaminate the water.

"Bather Count" means the number of bathers in an aquatic venue at any given time.

"Best Practice" means a technique or methodology that, through experience and research, has been proven to reliably lead to a desired result.

"Body of Water" *(per NEC, q.v.)* means any aquatic venue holding standing water, whether permanent or storable.

"Breakpoint Chlorination" means the conversion of inorganic chloramine compounds to nitrogen gas by reaction with Free Available Chlorine. When chlorine is added to water containing ammonia *(from urine, sweat, or the environment, for example)*, it initially reacts with the ammonia to form monochloramine. If more chlorine is added, monochloramine is converted into dichloramine, which decomposes into nitrogen gas, hydrochloric acid, and chlorine. The apparent residual chlorine decreases since it is partially reduced to hydrochloric acid. The point at which the drop occurs is referred to as the "breakpoint." The amount of free chlorine that must be added to the water to achieve breakpoint chlorination is approximately 10 times the amount of COMBINED CHLORINE in the water. As additional chlorine is added, all inorganic COMBINED CHLORINE compounds disappear, resulting in a decrease in eye irritation potential and "chlorine odors."

"Bulkhead" means a movable partition that physically separates a pool into multiple sections.

"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."

"Chemical Storage Space" means a space in an aquatic facility used for the storage of pool chemicals such as acids, salt, or corrosive or oxidizing chemicals.

"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.

- **"Available Chlorine"** means the amount of chlorine in the +1 oxidation state, which is the reactive, oxidized form. In contrast, chloride ion *(Cl^-)* is in the -1 oxidation state, which is the inert, reduced state.
    - Available Chlorine is subdivided into Free Available Chlorine and Combined Available Chlorine. Pool chemicals containing Available Chlorine are both oxidizers and disinfectants. Elemental chlorine *(Cl_2)* is defined as containing 100% available chlorine. The concentration of Available Chlorine in water is normally reported as ppm (*mg/L*) "as Cl_2," that is, the concentration is measured on a Cl_2 basis, regardless of the source of the Available Chlorine.
- **"Combined Available Chlorine"** or **"Combined Chlorine"** or **"CAC"** or **"CC"** means the concentration of available chlorine present in the form of inorganic or organic chloramines. Combined available chlorine is less reactive than free available chlorine and organic chloramines are generally less reactive oxidizers than the inorganic chloramines. Combined chlorine is determined by taking the difference between the Total Chlorine *(TC)* and DPD-FC concentrations. CC = TC – DPD-FC.
- "**Cyanurate-bound available chlorine**" or "**CBC**" means the concentration of available chlorine that is bound to cyanurate.
- **"DPD Free Chlorine" or "DPD-FC"** means the FC *("free chlorine")* concentration from DPD-based test methods. The DPD-based test result for FC includes cyanurate-bound available chlorine as well as HOCl and OCl^-, that is, DPD-FC = FAC + CBC. The terms DPD-FC and FAC would be interchangeable only in the absence of cyanuric acid.
- **"Free Available Chlorine" or "FAC" or "Free Chlorine Residual"** means the portion of the total available chlorine that is not "combined chlorine" or "cyanurate-bound available chlorine" and is primarily present as hypochlorous acid *(HOCl)* or hypochlorite ion *(OCl^-)*. Molecular chlorine *(Cl_2)*, trichloride *(Cl_3^-)*, and chlorine monoxide *(Cl_2O)* are also present at very low concentrations, depending on chlorine ion concentration, and these compounds are also counted as free available chlorine. The pH of the water determines the relative amounts of HOCl and OCl^-. HOCl is a very effective biocide and is the active biocide in pool water. OCl^- is also a biocide but acts more slowly than HOCl. Thus, chlorine is a more effective biocide at low pH than at high pH. A free chlorine residual must be maintained for adequate disinfection.
- **"Total Available Chlorine"** means the "TC" concentration from DPD-based test methods with iodide reagent added. All forms of available chlorine which react with iodide are measured as Total Available Chlorine *(TC)*.

"Circulation Path" means an exterior or interior way of passage from one part of an aquatic facility to another for pedestrians, including, but not limited to walkways, pathways, decks, and stairways.

"Cleansing Shower" *See "Shower."*

"Climate Control System" means a combination of the pieces of equipment designed to control the temperature, humidity, introduce ventilation air and maintain building negative pressure.

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

"Combustion Device" means any appliance or equipment using fire. These include, but may not be limited to, gas or oil furnaces, boilers, pool heaters, domestic water heaters, etc.

"Construction Joint" means a watertight joint provided to facilitate stopping places in the construction process. Construction joints also serve as contraction joints which control cracking.

"Contaminant" means a substance that soils, stains, corrupts, or infects another substance by contact or association.

"Contamination Response Plan" means a plan for handling contamination from formed-stool, diarrheal-stool, vomit, and blood.

"Corrosive Material" means pool chemicals, fertilizers, cleaning chemicals, oxidizing cleaning materials, salt, de-icing chemicals, other corrosive or oxidizing materials, pesticides, and such other materials which may cause injury to people or damage to the building, air-handling equipment, electrical equipment, safety equipment, or fire-suppression equipment, whether by direct contact or by contact via fumes or vapors, whether in original form or in a foreseeably likely decomposition, pyrolysis, or polymerization form. Refer to labels and SDSs.

"Crack" means any and all breaks in the structural shell of a pool vessel or deck.

"Cross-Connection" means a connection or arrangement, physical or otherwise, between a potable water supply system and a plumbing fixture, tank, receptor, equipment, or device, through which it may be possible for non-potable, used, unclean, polluted, and contaminated water, or other substances to enter into a part of such potable water system under any condition.

"CT Inactivation Value" means the concentration of a particular disinfectant *(C)* multiplied by the contact time in minutes *(T)* needed for inactivation of a particular microorganism. The CT value is approximately constant; therefore, the higher the concentration of the disinfectant, the shorter the contact time required for inactivation. The CT inactivation value applies to a given level of inactivation, for example a 3-log (99.9%) reduction and can vary with pH or temperature so these values must also be supplied to allow comparison between values.

"Deck" means surface areas serving the aquatic venue, including the dry deck, perimeter deck, and pool deck.

- **"Dry Deck"** means all pedestrian surface areas within the aquatic venue enclosure not subject to frequent splashing or constant wet foot traffic. The dry deck is not perimeter deck or pool deck, which connects the pool to adjacent amenities, entrances, and exits. Landscape areas are not included in this definition.
- **"Perimeter Deck"** means the hardscape surface area immediately adjacent to and within 4 feet *(1.2 m)* of the edge of the swimming pool also known as the "wet deck" area.
- **"Pool Deck"** means surface areas serving the aquatic venue, beyond perimeter deck, which is expected to be regularly trafficked and made wet by bathers.
- **"Wet Deck"** means the sum of the perimeter deck and pool deck.

"Design Professional" means a person who is registered or licensed to practice their respective design profession as defined by the local, state, territorial, federal, and tribal laws governing professional practice within the jurisdiction where the project is to be constructed.

"Designated Swimming Area" (DSA) means a zone of water within an Artificial Swimming Lagoon used for swimming, wading, or bathing. Typically, a DSA is separated from the water sports area using a rope and float line or similar device approved by the Authority Having Jurisdiction. Constant flow of treated water into DSAs ensure water quality. The flowing water displaces potentially contaminated water from the DSAs, creating a positive hydraulic gradient from DSAs into the water sports area. Water is removed from the water sports area and treated before it is returned to the DSAs. Typically, DSAs are shallower than the open-water areas used for boating, kayaking, and paddle-boarding. Swimming, wading, and bathing are not permitted outside of DSAs.

"Diaper-Changing Station" means a hygiene station that includes a diaper-changing unit, handwashing sink, soap and dispenser, a means for drying hands, trash receptacle, and disinfectant products to clean after use.

"Diaper-Changing Unit" means a diaper-changing surface that is part of a diaper-changing station.

"Dichloramine" means a disinfection byproduct formed when chlorine binds to nitrogenous waste in pool water to form an amine-containing compound with two chlorine atoms *($NHCl_2$)*. It is a known acute respiratory and ocular irritant.

"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 Byproduct" *(DBP)* 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)*.

"Diving Pool" *See "Pool."*

"Drop Slide" *See "Slide."*

"Dry Deck" *See "Deck."*

"Emergency Action Plan" *(EAP)* means a plan that identifies the objectives that need to be met for a specific type of emergency, who will respond, what each person's role will be during the response and what equipment is required as part of the response.

"Enclosure" means an uninterrupted constructed feature or obstacle used to surround and secure an area that is intended to effectively prevent unpermitted, uncontrolled, and unfettered access. It is designed to resist climbing and to prevent passage through it and under it. Enclosure can apply to aquatic facilities or aquatic venues.

"EPA Registered" means all products regulated and registered under the Federal Insecticide, Fungicide, and Rodenticide Act *(FIFRA)* by the EPA.

"Equipment Room or Area" means a space intended for the operation of pool pumps, filters, heaters, and controllers. This space is not intended for the storage of hazardous pool chemicals.

"Exit Gate" means an emergency exit, which is a gate or door allowing free exit at all times.

"Expansion Joint" means a watertight joint provided in a pool vessel used to relieve flexural stresses due to movement caused by thermal expansion/contraction.

"Fixture" *See "Plumbing Fixture" or "Hygiene Fixture."*

"Flat Water" *See "Theoretical Peak Occupancy."*

"Floatation Tank" *(a.k.a. Float Tank, Float Room/Pod/Spa/Chamber, Isolation Tank, or Sensory Deprivation Tank)* means a tub that contains a saturated solution of magnesium sulfate having a specific gravity of 1.23 to 1.3, provides a light and sound reduced environment, and is maintained at a temperature of approximately 92–96°F / 33.3–35.6°C.

"Floatation Tank Solution" means a saturated solution of magnesium sulfate having a specific gravity of 1.23 to 1.3.

"Flume" means the riding channels of a waterslide which accommodate riders using or not using mats, tubes, rafts, and other transport vehicles as they slide along a path lubricated by a water flow.

"Foot Bath" means standing water in which bathers or aquatics staff rinse their feet.

"Free Chlorine Residual" or **"Free Available Chlorine"** *See "Chlorine."*

"Ground-Fault Circuit Interrupter" *(GFCI)* means a device for protection of personnel that de-energizes an electrical circuit or portion thereof in the event of excessive ground current.

"Handwashing Station" means a location which has a handwashing sink, adjacent soap with dispenser, hand drying device or paper towels and dispenser, and trash receptacle.

"Hot Water" *See "Theoretical Peak Occupancy."*

"Hygiene Facility" means a structure or part of a structure that contains toilet, shower, diaper-changing unit, handwashing station, and dressing capabilities serving bathers and patrons at an aquatic facility.

"Hygiene Fixtures" means all components necessary for hygiene facilities including plumbing fixtures, diaper-changing stations, handwashing stations, trashcans, soap dispensers, paper towel dispensers or hand dryers, and toilet paper dispensers.

"Hyperchlorination" means the intentional and specific raising of free available chlorine concentrations for a prolonged period of time to inactivate pathogens following a fecal or vomit release in an aquatic venue.

"Imminent Health Hazard" means a substantial threat or danger to health that is considered to exist when there is evidence sufficient to show that a product, practice, circumstance, or event creates a situation that requires immediate correction or cessation of operation to prevent injury based on the number of potential injuries and the nature, severity, and duration of the anticipated injury or illness.

"Increased Risk Aquatic Venue" *See "Aquatic Venue."*

"Indoor Aquatic Facility" means a physical place that contains one or more aquatic venues and the surrounding bather and spectator/stadium seating areas within a structure that meets the definition of "Building" per the International Building Code *(IBC)*. "Indoor Aquatic Facility" does not include equipment, chemical storage, or bather hygiene rooms or any other rooms with a direct opening to the aquatic facility. Otherwise known as a natatorium.

"Infinity Edge" means a pool wall structure and adjacent perimeter deck that is designed in such a way where the top of the pool wall and adjacent deck are not visible from certain vantage points in the pool or from the opposite side of the pool. Water from the pool flows over the edge and is captured and treated for reuse through the normal pool filtration system. They are often also referred to as "vanishing edges," "negative edges," or "zero edges."

"Inlet" means wall or floor fittings where treated water is returned to the pool.

"Interactive Water Play Aquatic Venue" means any indoor or outdoor installation that includes sprayed, jetted, or other water features where water contacts bathers, whether recirculated or non-recirculated *(also known as "single pass")*, 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, and wet decks.

"Interior Space" means any substantially enclosed space having a roof and having a wall or walls which might reduce the free flow of outdoor air. Ventilation openings, fans, blowers, windows, doors, etc., shall not be construed as allowing free flow of outdoor air.

"Island" means a structure inside a pool where the perimeter is completely surrounded by the pool water and the top is above the surface of the pool.

"Landing Pool" *See "Pool."*

"Lazy River" *See "Aquatic Venue."*

"Lifeguard Supervisor" means an individual responsible for the oversight of lifeguard performance and emergency response at an aquatic facility, who has successfully completed a lifeguard supervisor training course that meets the requirements of this code, and who holds a valid certificate for such training.

"mg/L" means milligrams per liter and is the equivalent metric measure to parts per million *(ppm)*.

"Moisture Removal Capacity" means the amount of condensate produced by the climate control equipment which includes the effects of reheat coils, circulating fans and other components in the air stream; excluding supplementary heating, cooling, or outdoor air; and expressed in pounds of moisture/hour.

"**Moisture Removal Efficiency**" *(MRE)* means a ratio of the MRC in pounds of moisture/hour to the power input values in kilowatts at any given set of Rating Conditions expressed in pounds of moisture/kilowatt hour.

"Monitoring" 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.

"Moveable Floors" means a pool floor whose depth varies through the use of controls.

"No Diving Marker" means a sign with the words "No Diving" and the universal international symbol for "No Diving" pictured as an image of a diver with a red circle with a slash through it.

"Noise Criterion" means the single number rating that is somewhat sensitive to the relative loudness and speech interference properties of a given noise spectrum. The method consists of a family of criterion curves extending from 63 to 8,000 Hz and a tangency rating procedure. The criterion curves define the limits of octave band spectra that must not be exceeded to meet occupant acceptance in certain spaces.

"Non-Recirculated" means that the water used to fill an aquatic venue or to feed aquatic features is not recirculated through a treatment system for filtration and disinfection, but rather is sourced from an approved water supply used only once in/on the aquatic venue and gets disposed of with a proper wastewater disposal method. For example, at a non-recirculated Interactive Water Play Aquatic Venue, water sprayed from an aquatic feature comes directly from the water supply, is used only once, and gets disposed of through sanitary drains).

"Non-Substantial Alteration" means the alteration, modification, or renovation of an aquatic facility or an aquatic venue where the total cost of the work is 50% or less of the replacement cost of the aquatic facility or the aquatic venue.

"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 either increasing the number of oxygen atoms or reducing the number of electrons of the contaminant or other chemical reaction, which allows the contaminant to be more readily removed from the water or made more soluble in the water.

"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.

"Peninsula / Wing Wall" means a structural projection into a pool intended to provide separation within the body of water.

"Perimeter Deck" *See "Deck."*

"Perimeter Gutter System" means a weir or trough around the perimeter of a swimming pool that is used to skim the surface of the water and return the water to the treatment system.

"pH" means 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 hypochlorous acid *(HOCl)* ionization occurs and chlorine DISINFECTANTS decrease in effectiveness.

"Plumbing Fixture" means a receptacle, fixture, or device that is connected to a water supply system or discharges to a drainage system or both and may be used for the distribution and use of water; for example: toilets, urinals, showers, and hose bibs.

"Pool" means a subset of aquatic venues designed to have standing water for total or partial bather immersion. This does not include spas.

- **"Activity Pool"** means a water attraction designed primarily for play activity that uses constructed features and devices including pad walks, flotation devices, and similar attractions.
- **"Diving Pool"** means a pool used exclusively for diving.
- **"Landing Pool"** means an aquatic venue or designated section of an aquatic venue located at the exit of one or more waterslide flumes. The body of water is intended and designed to receive a bather emerging from the flume for the purpose of terminating the slide action and providing a means of exit to a deck or walkway area.
- **"Skimmer Pool"** means a pool using a skimmer system.
- **"Surf Pool"** means any pool designed to generate waves dedicated to the activity of surfing on a surfboard or analogous surfing device commonly used in the ocean and intended for sport as opposed to general play intent for wave pools.
- **"Therapy Pool"** means a pool used exclusively for aquatic therapy, physical therapy, 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)*.
- **"Wave Pool"** means any pool designed to simulate breaking or cyclic waves for purposes of general play. A wave pool is not the same as a surf pool, which generates waves dedicated to the activity of surfing on a surfboard or analogous surfing device commonly used in the ocean and intended for sport as opposed to general play intent for wave pools.

"Pool Deck" *See "Deck."*

"Pool Slide" *See "Slide."*

"Public Water Systems" means water systems including community water systems, non-transient/non-community water systems, or transient non-community water systems with exceptions as noted by AHJ and EPA.

"Purge" means to introduce a large volume of outdoor air to flush the interior space.

"Qualified Lifeguard" means an individual who has successfully completed an AHJ-recognized lifeguard training course offered by an AHJ-recognized training agency, holds a current certificate for such training, has met the pre-service requirements, and is participating in continuing in-service training requirements of the aquatic facility.

"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.

"Raceway" means an enclosed channel of metallic or nonmetallic materials designed expressly for holding wires, cables, busbars, or additional functions as permitted.

"Recessed Steps" means a way of ingress/egress for a pool, similar to a ladder but the individual treads are recessed into the pool wall.

"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)*.

"Re-entrainment" means a situation where the exhaust*(s)* from a ventilated source such as an indoor aquatic facility is located too close to the air handling system intake*(s)*, which allows the exhausted air to be re-captured by the air handling system, so it is transported directly back into the aquatic facility.

"Responsible Supervisor" means an individual onsite that is responsible for water treatment operations when a "qualified operator" is not onsite at an aquatic facility.

"Reverberation" means the persistence of sound in an enclosed or partially enclosed space after the source of sound has stopped due to repeated reflections from the room surfaces; by extension, in some contexts, the sound that so persists.

"Reverberation Time – RT_{60}" means, for airborne sound, the time it takes a reverberant sound field to decay 60 dB after the source is interrupted. If an ambient sound field limits the ability to measure 60 dB of decay, then this time can be extrapolated for the measure of the shorter decay.

"Rinse Shower" *See "Shower."*

"Robotic Cleaner" means a modular vacuum system consisting of a motor-driven, in-pool suction device, either self-powered or powered through a low voltage cable, which is connected to a deck-side power supply.

"Rope and Float Line" means a continuous line not less than 1/4" *(6 mm)* in diameter and that is supported by buoys spaced no more than 5 feet apart to provide a visual and physical separation of the pool areas.

"Runout" means that part of a waterslide where riders are intended to decelerate and/or come to a stop. The runout is a continuation of the waterslide flume surface.

"Safety" *(as it relates to construction items)* means a design standard intended to prevent inadvertent or hazardous operation or use *(i.e., a passive engineering strategy)*.

"Safety Plan" means a written document that has procedures, requirements and/or standards related to safety which the aquatic facility staff shall follow. These plans include training, emergency response, and operations procedures.

"Safety Team" means any employee of the aquatic facility with job responsibilities related to the aquatic facility's emergency action plan.

"Safety Vacuum Release System" *(SVRS)* means as defined in 15 USC 8002 (5) "a vacuum release system capable of providing vacuum release at a suction outlet caused by a high vacuum occurrence due to a suction outlet flow blockage." A SVRS may be a mechanical device installed on the exposed single main suction pipe before a filtration or feature pump or an electrical device located as an attachment to the filtration or feature pump control system or is integral with the filtration or feature pump or motor itself.

"Sanitize" means reducing the concentration of microbes to that considered safe by public health standards.

"Saturation Index" means a mathematical representation or scale representing the ability of water to deposit calcium carbonate, or dissolve metal, concrete, or grout.

"Secondary Treatment" 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.

"Shower" means a device that sprays water on the body.

- **"Cleansing Shower"** means a shower located within a hygiene facility using warm water and soap. The purpose of these showers is to remove contaminants including perianal fecal material, sweat, skin cells, personal care products, and dirt before bathers enter the aquatic venue.
- **"Rinse Shower"** means a shower typically located in the pool deck area with ambient temperature water. The main purpose is to remove dirt, sand, or organic material prior to entering the aquatic venue to reduce the introduction of contaminants and the formation of disinfection byproducts.

"Skimmer" means a device installed in the pool wall whose purpose is to remove floating debris and surface water to the filter. They shall include a weir to allow for the automatic adjustment to small changes in water level, maintaining skimming of the surface water.

"Skimmer Pool" *See "Pool."*

"Skimmer System" means periodic locations along the top of the pool wall for removal of water from the pool's surface for treatment.

"Slide" means an aquatic feature where users slide down from an elevated height into water.

- **"Drop Slide"** means a slide that drops bathers into the water from a height above the water versus delivering the bather to the water entry point.
- **"Pool Slide"** means a slide similar in construction to a playground slide used to allow users to slide from an elevated height to a pool. They shall include children's *(tot)* slides and all other non-flume slides that are mounted on the pool deck or within the basin of a public swimming pool.
- **"Waterslide"** means a slide that runs into a landing pool or runout through a fabricated channel with flowing water.

"Slip Resistant" means surfaces shall have a minimum dynamic coefficient of friction at least equal to the requirements of ANSI A326 for that installation as measured by the DCOF AcuTest.

"Sound Absorption" means (1) the process of dissipating sound energy and (2) the property possessed by materials, objects, and structures, such as rooms, for absorbing sound energy.

"Sound Transmission Class" (STC) means a one-number rating of the sound-blocking ability of a partition, door, window, etc., calculated in accordance with ASTM E413 from measurements of one-third-octave band sound pressure levels and sound absorption made in a laboratory and in accordance with ASTM E90.

"Spa" *See "Aquatic Venue."*

"Special Use Aquatic Venue" *See "Aquatic Venue."*

"Stadium Seating" *See "Theoretical Peak Occupancy."*

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

"Storage" means the condition of remaining in one space for 1 hour or more. Materials in a closed pipe or tube awaiting transfer to another location shall not be considered to be stored.

"Structural Crack" means a break or split in the pool surface that weakens the structural integrity of the vessel.

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

"Superchlorination" means the addition of large quantities of chlorine-based chemicals to kill algae, destroy odors, or improve the ability to maintain a disinfectant residual.

"Supplemental Treatment" 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.

"Surf Pool" *See "Pool."*

"SVRS" *See "Safety Vacuum Release System."*

"Theoretical Peak Occupancy" means the anticipated peak number of bathers in an aquatic venue or the anticipated peak number of occupants of the decks of an aquatic facility. This is the lower limit of peak occupancy to be used for design purposes for determining services that support occupants. Theoretical peak occupancy is used to determine the number of showers. For aquatic venues, the theoretical peak occupancy is calculated around the type of water use or space:

- **"Agitated Water"** means an aquatic venue with mechanical means *(aquatic features)* to discharge, spray, or move the water's surface above or below the static water line of the aquatic venue so people are standing or playing vertically. Where there is no static water line, movement shall be considered above the deck plane. Recirculation though either floor or wall inlets shall not be considered agitated water.
- **"Flat Water"** means an aquatic venue in which the water line is static except for movement made by users usually as a horizontal use as in swimming. Diving spargers do not void the flat water definition.
- **"Hot Water"** means an aquatic venue with a water temperature over 90°F *(32°C)*.
- **"Stadium Seating"** means an area of high-occupancy seating provided above the pool level for observation.

"Therapy Pool" *See "Pool."*

"Toe Ledge" *See "Underwater Ledge."*

"Total Bromine" means the amount of bromine in the +1 oxidation state, which is the reactive, oxidized form. Commercially available test kits are not capable of distinguishing free bromine *(Br_2, HOBr, OBr^-)* from combined bromine *(bromamines)*. The bromine value specified in test results is the concentration of total bromine.

"Trichloramine" means a disinfection byproduct formed when chlorine binds to nitrogenous waste in pool water to form an amine-containing compound with three chlorine atoms *(NCl_3)*. It is a known acute

respiratory and ocular irritant. It has low solubility in water and is rapidly released into the air above pools where it can accumulate, particularly in indoor settings.

“Trihalomethanes” *(THM)* means chemical compounds in which three of the four hydrogen atoms of methane *(CH_4)* are replaced by halogen atoms. Trihalomethanes are environmental pollutants, and many are considered carcinogenic.

"Turnover" or **"Turnover Rate"** or **“Turnover Time”** means the period of time, usually expressed in hours, required to circulate a volume of water equal to the capacity of the aquatic venue.

“Underwater Bench” means a submerged seat with or without hydrotherapy jets.

“Underwater Ledge” or **“Underwater Toe Ledge”** means a continuous step in the pool wall that allows swimmers to rest by standing without treading water.

“UV Transmissivity” means the percentage measurement of ultraviolet light able to pass through a solution.

“Wading Pool” *See “Pool.”*

“Waterslide” *See “Slide.”*

“Water Quality Testing Device” *(WQTD)* means a product designed to measure the level of a parameter in water. A WQTD includes a device or method to provide a visual indication of a parameter concentration and may include one or more reagents and accessory items.

“Water Replenishment System” means a way to remove water from the pool as needed and replace with make-up water to maintain water quality.

“Wave Pools” *See “Pool.”*

“Wet Deck” *See “Deck.”*

“Wing Wall / Peninsula” *See “Peninsula / Wing Wall.”*

“Zero Depth Entry” means a sloped entry into a pool from deck level into the interior of the pool as a means of access and egress.

3.0 Cited Standards and Laws

Nothing in this CODE is intended to exempt an AQUATIC FACILITY or associated AQUATIC VENUES from any applicable local, state, territorial, federal, and tribal laws. Other applicable requirements may include but are not limited to building CODES, mechanical CODES, plumbing CODES, electrical CODES, fire CODES, FDA Food Code, OSHA requirements, EPA requirements, and the Code of Federal Regulations. Additional permits and inspections may be required based on the requirements of other applicable laws.

Acoustical Society of America (ASA)

- ANSI/ASA S12.60-2010/Part 1 (R2015), Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools
- ANSI/ASA S12.60-2009/Part 2 (R2014), Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

Air Conditioning Contractors of America (ACCA)

- ANSI/ACCA 10 Manual SPS-2011 (RA 2017); Manual SPS HVAC Design for Swimming Pools and Spas

Air Conditioning Heating and Refrigeration Institute (AHRI)

- ANSI/AHRI Standard 910 (I-P), 2014 Standard for Performance Rating of Indoor Pool Dehumidifiers
- ANSI/AHRI Standard 920 (I-P), 2020 Standard for Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units

Air Movement Control Association (AMCA)

- AMCA 201-02 (R2011), Fans and Systems

American Coatings Association (ACA)

- Hazardous Materials Identification System (HMIS), 4th Edition

American Concrete Institute (ACI)

- ACI 302.1R-15, Guide to Concrete Floor and Slab Construction

American Heart Association (AHA)

- American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC)
- 2020 AHA Guidelines Update for CPR and ECC
- www.citizencpr.org

American National Standards Institute (ANSI)

- ANSI/ICC A117.1-2017. Accessible and Usable Buildings and Facilities
- ANSI A137.1:2017 American National Standards Specifications for Ceramic Tile

American National Standards Institute / International Aquatic Foundation (IAF)

- ANSI/IAF-9

American National Standards Institute / International Safety Equipment Association (ISEA)

- ANSI /ISEA Z308.1-2015: American National Standard – Minimum Requirements for Workplace First Aid Kits and Supplies

American Red Cross (ARC)

- American Red Cross, Lifeguarding Manual, 2017

American Safety & Health Institute (ASHI)

- ASHI CPR, AED and Basic First Aid Combination Training, 2018

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

- ANSI/ASHRAE Standard 62.1-2019: Ventilation for Acceptable Indoor Air Quality
- 2019 ASHRAE Handbook – HVAC Applications
- 2017 ASHRAE Handbook – Fundamentals

American Society of Mechanical Engineers (ASME)

- ASME A112.19.17-2010, Manufactured Safety Vacuum Release Systems (SVRS) for Residential and Commercial Swimming Pool, Spa, Hot Tub, and Wading Pool Suction Systems

ASTM International (formerly American Society for Testing and Materials) (ASTM)

- ASTM E90 – 09 (2016): Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- ASTM E413 – 16 (2016): Classification for Rating Sound Insulation
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- ANSI Z21.13-2017/CSA 4.9-2017 – Gas-Fired Low Pressure Steam and Hot Water Boilers
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Chlorine Institute (CI)

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Citizen CPR Foundation (CCPRF)

- ECCU Emergency Cardiovascular Care Update Conference
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- 40 CFR Subchapter E – Pesticide Programs

Food and Drug Administration (FDA)

- Food Code: 2017 Recommendations of the United States Public Health Service Food and Drug Administration

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- See American Coatings Association above

Health Canada Pest Management Regulatory Agency (PMRA)

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Illuminating Engineering Society of North America (IESNA)

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- The Lighting Handbook, 10th Edition (2011)

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- IEEE Std 241-1990 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (reaffirmed in 1997)

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- Soares Grounding and Bonding, 13th Edition, 2017

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- ANSI Z223.1/NFPA 54: National Fuel Gas Code, 2018 Edition
- NFPA 70: National Electrical Code (NEC), 2020 Edition
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- NFPA 5000: Building Construction and Safety Code, 2018 Edition
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- NSF/ANSI 60 – 2020, Drinking Water Treatment Chemicals – Health Effects
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Occupational Safety and Health Administration (OSHA)

- 29 CFR 1910.304 Wiring design and protection
- 29 CFR 1910.1000 Air Contaminants
- 29 CFR 1910.1030 Bloodborne Pathogens
- 29 CFR 1910.1200 Hazard Communication
- 29 CFR 1910.1200(g) Safety Data Sheets (SDS)

Österreichisches Normungsinstitut (ÖNORM)

- Austrian Standards Institute

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- Swimming Pool Water: Treatment and Quality Standards for Pools and Spas, 3rd Edition, 2017

Propane Education and Research Council (PERC)

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- UL 399 2017-03-20 Standard for Drinking-Water Coolers
- UL 508 2018-01-28 Standard for Industrial Control Equipment
- UL 676 2015-08-10 Standard for Underwater Luminaries and Submersible Junction Boxes
- UL 727 2018-01-31 Standard for Oil-Fired Central Furnaces
- UL 1081 2016-08-09 Standard for Swimming Pool Pumps, Filters, and Chlorinators
- UL 1241 2003-06-11 Standard for Junction Boxes for Swimming Pool Luminaries
- UL 1777 2015-10-02 Standard for Chimney Liners
- UL 1995 2015-07-31 Heating and Cooling Equipment
- UL 2075 2013-03-05 Standard for Gas and Vapor Detectors and Sensors
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4.0 Aquatic Facility Design Standards and Construction

Basic Design Considerations for Handling Particle Contamination Burden, Chlorine and Disinfectant Demand, and Disinfection Byproduct Issues

Filtration Flow Rate

The particle contamination burden determines the filtration flow rate for a given AQUATIC VENUE. It is not possible to predict the particle contamination burden for every individual AQUATIC VENUE because the sources will likely vary substantially from one AQUATIC VENUE to another. However, it is important to understand the upper limit of particle contamination to provide information for filtration designs. If the upper limit of the particle contamination burden is known, then it should be possible for the designer to specify a filtration system that can handle the maximum particle burden and ensure that water turbidity does not increase at least above an allowable level. Essentially, the RECIRCULATION SYSTEM needs to be designed to remove particles at least at the same rate at which they are being added by the environment *(e.g., windblown and settling dust)*, BATHERS *(e.g., personal care products, body excretions)*, and other sources.

Determining Maximum Rate of Particle Contamination

The best means for determining this maximum rate of particle contamination is through direct measurement to ensure the data are indicative of normal activity. The rate of contamination *(n, particles/ time/gallon)* is likely to vary by AQUATIC VENUE location, BATHER COUNTS, BATHER age, time of year, time of day, weather, and proximity to urban and desert environments.

Data Search

An extensive literature search found no relevant data defining the particulate contamination burden in AQUATIC VENUES. It is recommended that a model be developed that describes particle addition and subsequent removal by the filtration system. This would include developing a correlation between particle size and turbidity or clarity index; this correlation is needed from a practical point of view since future regulations are likely to be developed based on turbidity or clarity. These data could then be used for making concrete, data-based decisions on removal rate requirements and help with defining the required filtration and circulation capacities.

Disinfectant Demand

DISINFECTANT consumption can occur by the reaction of the DISINFECTANT with BATHERS, BATHER waste, and other environmentally introduced CONTAMINANTS, as well as simple decomposition of the active halides *(i.e., HOCl or HOBr)* into inactive halide ions *(chloride or bromide)*. DISINFECTANT decomposition rates will also vary depending on a variety of factors including pH, water temperature, UV light, and BATHER COUNT. Data on DISINFECTANT demand are generally lacking in the literature on EPA–REGISTERED DISINFECTANTS. There are some data available for CHLORINE DISINFECTANT demand, but there are very few for bromine, PHMB, and metal systems.

Chlorine Disinfectant Demand

Contribution of Bather Count

Several studies have investigated the BATHER COUNT's contribution to CHLORINE demand in AQUATIC VENUE water; however, there is a lack of consistency in how BATHER COUNT was measured. Some studies report data as CHLORINE demand, others as potassium permanganate demand, dissolved organic carbon, or total organic carbon.[2-5]

Varies in Magnitude

The available data for CHLORINE DISINFECTANT demand indicates that the CHLORINE demand from BATHERS can vary by over an order of magnitude, with the largest value measured being 10 g Cl_2/BATHER *(or 2.2 lb/100 BATHERS)*.[5]

Simple Decomposition of Chlorine

There are few published data on the CHLORINE demand that occurs in AQUATIC VENUES due to the simple decomposition of CHLORINE. It is well known that CHLORINE is not stable at high temperatures and in the presence of UV. Both factors will reduce active CHLORINE to inactive chloride, without any BATHER waste being present.

Rate of Chlorine Loss

The rate of CHLORINE loss *(pounds of CHLORINE per hour)* due to UV degradation will depend on a number of factors, including the size of the AQUATIC VENUE, the depth of the water, and the intensity of the sunshine. It will also depend on the concentration of CYA present, since CYA can help prevent the decomposition of CHLORINE by UV. Given the number of variables, it is difficult to predict CHLORINE decomposition rates in specific AQUATIC VENUES.

Reducing Chlorine Loss

The rate of CHLORINE loss can be reduced by using other oxidizers, including potassium monopersulfate and ozone, or UV, which can destroy CONTAMINANTS which would otherwise react with CHLORINE. Additional research on the contributing factors to DISINFECTANT demand *(i.e., nitrogenous waste)* might be warranted in the future as treatment methods are developed to reduce or eliminate them by means other than OXIDATION. It is anticipated that this research would identify the introduction rate of the CONTAMINANT, resulting concentrations, and the effect that reduction or elimination of this CONTAMINANT would have on DISINFECTANT demand or other ancillary benefits *(i.e., reduction of COMBINED CHLORINES)*.

Chemical Feed Pump Sizing

Further data collection on CHLORINE usage in real world AQUATIC VENUE situations under different environmental and operational conditions could be used to develop an effective rate law from which the sizing of chemical feed pumps could then be calculated.[6, 7] The criteria for specifying a chemical feed pump for an AQUATIC VENUE are based on its ability to feed against the process piping pressure and to provide sufficient feed rate to maintain a DISINFECTANT residual in the water. Several states require chemical feed pumps for CHLORINE to be capable of providing up to 10 ppm of CHLORINE in the pipe returning water from the RECIRCULATION SYSTEM back to the POOL. Once actual CHLORINE usage is obtained, a surplus SAFETY factor could be introduced to slightly oversize the feed pump to ensure that the DISINFECTANT dosing amount can be increased to meet increases in demand. Any such sizing requirements need to specify the timeframe within which the pump must be able to satisfy the CHLORINE dosing required.

Disinfection Byproduct Issues

Chlorination of Water

Chlorination, using CHLORINE as the DISINFECTANT, is the most common procedure for AQUATIC VENUE water DISINFECTION and inactivation of waterborne microbial pathogens. BATHER activity and environmentally introduced material provides a broad range of precursors with which DISINFECTANTS can react *(e.g., perspiration, urine, mucus, skin particles, hair, body lotions, fecal material, soil, etc.)*. When CHLORINE reacts with these precursors, a variety of chemical reactions take place, including the formation of DBPs[8-12]. DBPs might also be introduced into the AQUATIC VENUE via the water used to fill the AQUATIC VENUE depending on the quality of water supply. Municipal fill water can also include chloramines as some municipal systems switch from chlorination to chloramination to meet EPA DBP requirements.[13] CHLORINE gas, if used, is extremely toxic.[14-16]

Types of Disinfection Byproducts

DBPs can be organic[10, 17] *[e.g., THMs, chlorinated phenols, haloketones, haloacetic acids, and haloacetonitriles (HANs)]* or inorganic[18-20] *(e.g., chloramines and cyanogen chloride)*. The major by-products of DISINFECTION using HOBr and HOCl are bromoform *($CHBr_3$)* and chloroform *($CHCl_3$)*, respectively. Chloroform and bromoform are highly volatile compounds that can be inhaled in AQUATIC VENUE environments and also readily absorbed through the skin.[21-23]

Classes of Organic DBPs

Some classes of organic DBPs[22] are:

- THMs *(total THM is the sum of the concentrations of chloroform, bromoform, bromodichloromethane, and dibromochloromethane)*;
- Chlorinated phenols *(2-chloro-, 2,4-dichloro- and 2,4,6-trichlorophenol)*, haloketones *(1,1-dichloropropanone, 1,1,1-trichloropropanone)*;
- Haloketones *(bromopropanone, 1,1-dichloropropanone, 1,1,1-trichloropropanone, etc.)*;
- Haloacetic acids *(total haloacetic acids include the sum of the concentrations of mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids)*;
- Haloacetonitriles include *(dichloro-, trichloro-, dibromo- and bromochloroacetonitrile)*, chloropicrin, chloral hydrate, 3-chloro-4-*(dichloromethyl*)-5-hydroxy-2*(5H)*-furanone, etc.; and
- Organic chloramines.

Trihalomethane Concentration in Drinking Water

According to European Union regula*tions, the concentration of THMs in drinking water should not exceed 100 micrograms per liter* (100 µg/L) of water for consumption[24]; while in the United States the EPA has established a legal maximum of 80 µg/L[13]. The DIN 19643-1 Swimming Pool Standard specifies a STANDARD maximum of 20 µg/L.[25]

Inorganic DBPs

Inorganic DBPs include chloramines and cyanogen chloride. Inorganic chloramines include monochloramine *(NH_2Cl)*, DICHLORAMINE *($NHCl_2$)* and TRICHLORAMINE *(NCl_3)* and are generated from the reaction of hypochlorite with ammonia and amino compounds that originate from sweat and urine of the swimmers. TRICHLORAMINE is relatively volatile and partitions easily from water into air.[26]

Factors That Determine DBP Concentrations

The conditions that determine production and air concentrations of DBPs have been suggested to depend on several factors:

- Number of swimmers in the AQUATIC VENUE and their associated hygiene
- CHLORINE concentration
- Water temperature
- Concentration of organic precursors in the AQUATIC VENUE water
- Chemical structure of the organic precursors
- Bromide content
- Indoor air circulation
- The extent of out-gassing of volatile DBPs
- pH
- Level of water agitation *(undisturbed vs. being sprayed)*, and
- Concentration of inorganic chloramine from the fill water

Further research is needed to determine how much DBPs are being created in AQUATIC VENUE water, including the production and retention rate.

Health Effects

Outbreaks of ocular and respiratory distress associated with indoor air quality have been documented.[27-33] Numerous studies have examined the link between air quality in INDOOR AQUATIC FACILITIES and ocular, dermal, and respiratory health effects, including asthma, with mixed results in swimmers, occupational categories such as lifeguards, and elite swimmers who practice regularly for extended times.[34-44] To date, however, several analyses of the data find the link to asthma is inconclusive.[11, 45-47] Multiple large studies available now suggest swimming does not increase the risk of asthma.[42, 44, 47, 48] To the contrary, one prospective study found swimming increased lung function and reduced the risk of asthma symptoms at 7 years of age.[44] Another large study showed that children ages 6–12 years, who swam regularly before age 2 years, did not have an increased risk of asthma, wheezing, or eczema.[42] The health benefits associated with

swimming might therefore include improvement of asthma symptoms and cardiovascular fitness. Pediatricians have long recommended swimming for asthmatic children because of its lower asthmogenicity compared with other forms of exercise. The Belgian Superior Health Council[49] reviewed the available science related to AQUATIC VENUE swimming and the development of childhood asthma. The Council, in its 2011 report No. 8748 *(and reiterated in its 2012 report)* concludes swimming remains highly advisable, even in the case of asthma. According to the Council, "For this target group, the advantages of swimming under good hygienic conditions in MONITORED AQUATIC VENUES outweigh the risk of toxicity linked to CHLORINE and its by-products." Also see Annex 4.6.2.1.

Benefits Outweigh Risks

Despite the health risks of DBPs in general, the concentration of organic DBPs found in AQUATIC VENUES is generally low. Therefore, although research results have shown that DBPs do form in detectable concentrations in most AQUATIC VENUES[50-52] and levels of exposure can be measured[53, 54] it appears that the benefits of DISINFECTION far outweigh the risks posed by its by-products[55]. The World Health Organization, states that "the risks from exposure to chlorination by-products in reasonably well-managed AQUATIC VENUES would be considered to be small and must be set against the benefits of aerobic exercise and the risks of infectious disease in the absence of DISINFECTION."[56] Improved water quality management is recommended to minimize formation and accumulation of these compounds.

Urea Concentrations in Pool Water

A major CONTAMINANT in AQUATIC VENUE water is urea. Urea is chiefly derived from swimmers urinating in AQUATIC VENUE water but is also present in swimmer's sweat. It has been shown that urea reacts with HOCl to produce TRICHLORAMINE. However, while breakpoint destruction of ammonia is very fast, reaction of HOCl with urea is very slow. Therefore, urea is difficult to remove quickly by shocking the AQUATIC VENUE water. There are no guidelines in the United States for MONITORING the urea concentration in AQUATIC VENUE water or suggested concentrations of concern. Input of urea is most effectively minimized by changes in swimmers' behavior and hygiene.[57-61]

4.1 Plan Submittal

4.1.1 Plan Submittal

4.1.2 Content of Design Report

4.1.2.1 Basis of Design Report

4.1.2.1.1 Names / Addresses

AQUATIC FACILITY plans should include a map indicating the exact location of the AQUATIC FACILITY with street address and geographic location information including the GPS coordinates.

4.1.2.3 Technical Specifications

4.1.2.3.1 Accompanying Drawings

Appurtenances include everything added to a POOL tank that can be used by swimmers or POOL operators. In addition to diving boards and platforms, WATERSLIDES, and other AQUATIC FEATURES, these also include handrails, grab rails, fill spouts, ladders, and ladder railings, floating lane dividers, POOL surface sprays under diving boards, starting platforms, floating play toys, POOL SLIDES, and other AQUATIC FEATURES.

4.1.2.3.2 Technical Details

Detailed specifications including POOL water temperatures, space design, dry bulb and dew point temperatures, and relative humidity are required to ensure that there is no misunderstanding, ambiguity, or omission between the DESIGN PROFESSIONAL, owner/operator, and the AHJ reviewer.

4.1.2.3.2.2 Intended Use

The owner/operator and DESIGN PROFESSIONALS *(engineer and architect)* need to coordinate intended use, type of AQUATIC VENUE *(FLAT WATER, AGITATED WATER, HOT WATER)* and intended typical operating water

temperature. This is critical towards ensuring owner/operator expectations are fully met. It also helps ensure the HVAC system and building envelope are designed for intended use.

4.1.2.3.5 Theoretical Peak Occupancy

DESIGN PROFESSIONALS need to consider the THEORETICAL PEAK OCCUPANCY of an AQUATIC FACILITY as part of the design process. This requires calculation and integration of peak occupancy numbers for the water as well as the surrounding DECK and seating areas. The rationale for the THEORETICAL PEAK OCCUPANCY density factor numbers for specific AQUATIC VENUE types is as follows:

1. FLAT WATER
    a. These AQUATIC VENUES generally are for swimming.
    b. The density factor was established at 20 ft^2 per person. This represents an average horizontal BATHER occupying a 5-foot *(1.5 m)* by 4-foot *(1.2 m)* area.
    c. Assuming a BATHER is swimming horizontally; a full body length is an average 5 foot *(1.5 m)* with a 5-foot span to equal 25 ft^2 *(2.3 m^2)*. There was a need to account for higher densities in shallow areas where BATHERS wade vertically versus swim horizontally. The middle ground decided was 20 ft^2 *(1.9 m^2)*.
2. AGITATED WATER
    a. These AQUATIC VENUES generally are for wading, splashing, and enjoyment of features without swimming.
    b. The density factor was established at 15 ft^2 *(1.4 m^2)* per BATHER. This represents an average vertical BATHER occupying a 5-foot *(1.5 m)* by 3-foot *(91 cm)* area. This also complies with the Illinois Swimming Facility Code.
3. HOT WATER
    a. These AQUATIC VENUES generally are for lounging such as hot tubs, warming POOLS, etc.
    b. The density factor was established at 10 ft^2 *(0.9 m^2)* per BATHER. This represents an average user sitting in a 3-foot *(91 cm)* by 3-foot *(91cm)* area.
4. DECK and Spectator Areas
    a. For DECKS at leisure POOLS, one can assume a density factor of 50 ft^2 *(4.6 m^2)* per BATHER of DECK space based on Illinois Swimming Facility Code. When adding seating and tables, which separate groups, the square footage allows for a reduced density.
    b. For spectator areas, the MAHC Committee chose a density factor of 6.6 ft^2 *(0.6 m^2)* per PATRON for STADIUM SEATING from ASHRAE 62.1. This seating is generally well above the water level.

The density factors in MAHC 4.1.2.3.5.3 may be modified for higher BATHER or PATRON density, but they shall not be modified to be lower than the density factors listed. The DESIGN PROFESSIONAL of the AQUATIC FACILITY or AQUATIC VENUE can document the intended use is different. For example, a swimming POOL that is normally a FLAT WATER venue has a density factor of 20 ft^2 *(1.9 m^2)* per BATHER. However, when designing a FLAT WATER WADING POOL with more vertical use than horizontal swimming, the POOL would have a higher density of BATHERS so the density factor could be modified to 15 ft^2 *(1.4 m^2)* per BATHER.

Example: MAHC 4.1.2.3.5.3 assigns the letter D to represent the BATHER "density factor." The D number is listed in terms of square feet of POOL water surface per BATHER. This means that a numerically lower D results in a numerically higher number of BATHERS. When designing an AQUATIC FACILITY, if the expected use will be more BATHERS per square foot than what is listed, then it can be modified to reflect that *(i.e., if the expected BATHER density for FLAT WATER is 1/10 ft^2 instead of 1/20 ft^2, one can use 1/10 ft^2, but they cannot use 1/30 ft^2 for FLAT WATER)*.

4.1.2.3.6 Equipment Characteristics and Rating

Hydraulic computations for head loss should be included in the technical specifications and supplemental engineering data to ensure that proper TURNOVER TIMES, flow rates, filtration *(See MAHC Annex section 4.7.2.1.2)*, and disinfection capacities are achieved and sized to meet the requirements of the MAHC. Hydraulic calculations for piping and pumps should be prepared by a qualified engineer or DESIGN PROFESSIONAL. Settings for different pump curves on a variable frequency drive pump should be included in

the technical specifications to ensure that selected settings meet the required TURNOVER RATES, flow rate, and heal loss rates for the AQUATIC VENUE in all circulation conditions.

4.1.2.3.9 Equipment Specifications

Temperature and relative humidity may affect the water quality and energy loss in an AQUATIC VENUE. For example, if an indoor AQUATIC VENUE has a low relative humidity *(<50% humidity)*, the AQUATIC VENUE can have significant evaporation, which would lead to an increased cost to refill, chemically treat and balance, and reheat the water. If the air is not circulating and replaced with fresh air, there may not be a way for airborne CONTAMINANTS, such as TRICHLORAMINES, to be removed further reducing the water quality and producing a health hazard *(see MAHC Annex section 4.6.2.6)*.

4.1.3 Plan Approval

The construction of public AQUATIC FACILITIES should not be undertaken without a thorough review and approval of the proposed construction plans by the AHJ. Construction costs for AQUATIC FACILITIES can be in the millions of dollars and very costly mistakes in design and equipment choices can occur if plans are not reviewed before construction. These mistakes could result in both public health hazards and additional remodeling costs. Most AHJs require that plans be submitted for review and approval by the regulatory authority before a public AQUATIC FACILITY can be constructed. Although there is considerable variation in the amount of information and detail required on the plans, most of the jurisdictions require at least a plot plan with sufficient detail to allow for a reasonable review of the proposed project. The licensed professional engineer or architect should have at least 1 year of previous experience with public AQUATIC FACILITY design. Most states will allow any professional engineer or architect to design an AQUATIC FACILITY. However, since aquatic design technology is sufficiently complex, specific prior experience in AQUATIC FACILITY construction and design is strongly recommended. A minimum of 1 year of previous experience in AQUATIC FACILITY design and construction is recommended.

Any final approval of plans by the AHJ should be dependent on approval by all other appropriate agencies. For example, the assumption of responsibility for reviewing plans for structural SAFETY and ensuring the AQUATIC FACILITY is designed to withstand anticipated loading, not only the POOL shell, but also in cases where the POOL might be located on an upper floor of a building or a rooftop is generally that of the local, state, territorial, and tribal building departments. If there is no local, state, territorial, federal, or tribal building CODE department or no local, state, territorial, federal, or tribal laws, the DESIGN PROFESSIONAL or architect must assume responsibility. This may include requiring the architect or engineer to certify the structural stability of the POOL shell during full and empty conditions.

4.1.3.3 Replacements

Most jurisdictions allow for replacements in-kind.

4.1.4 Compliance Certificate

4.1.4.4 Systems Commissioning

"Commissioning" or "testing of BATHER SAFETY" means completing a test, evaluation, or demonstration that confirms that the AQUATIC FACILITY, AQUATIC VENUES, AQUATIC FEATURES, and other equipment in question does not compromise public health and SAFETY.

4.2 Materials

4.2.1 Aquatic Venues

4.2.1.5 Design Parameters

There are multiple forms of acceptable finishes available, including but not limited to: paint, marcite plaster finish, quartz plaster finish, aggregate plaster finish, vinyl or PVC liner / paneling systems, stainless steel, tile, etc. Each system has advantages and disadvantages associated with cost, durability, cleanability, etc. These advantages and disadvantages are also subject to installation design issues *(e.g., indoors/outdoors, above/below water level, environmental effects, freezing or temperature exposures, etc.)*.

4.2.1.7 Smooth Finish

SKIMMER POOLS require a 6 inch *(152 mm)* to 12 inch *(305 mm)* high finish due to the varying height of water associated with in-POOL surge capacity of SKIMMER POOL systems. Gutter or perimeter overflow systems require a minimum finish height of 2 inches *(51 mm)*. If dark colors are utilized for the POOL finish, the POOL finish should not exceed a maximum height of 12 inches *(305 mm)* for contrasting purposes. Typical finishes include tile, stainless steel, vinyl, fiberglass, etc.

4.2.1.8 Slip-Resistant

Water 3 feet *(0.9 m)* and less is considered shallow water and most BATHERS are capable of walking on the POOL bottom at these depths, so a SLIP-RESISTANT surface is required. At depths greater than 3 feet *(0.9 m)*, most BATHERS are sufficiently buoyant making the coefficient of friction for the POOL floor surface less important. SLIP-RESISTANT surfaces shall meet or exceed the minimum coefficient of friction as set forth by the following:

- ADAAG
- OSHA

4.2.2 Indoor Aquatic Facility

4.2.2.2 Condensation Prevention

Special care should be used in the construction of air-pressure-supported buildings to prevent the movement of moisture into building surfaces, conduits, etc. If condensation is not controlled, there is a possibility of structural damage to ceiling fixtures, wood, or drywall areas and/or mold growth *(See MAHC Annex section 4.6.4 for more discussion)*. If the indoor AQUATIC VENUE air space has a humidity lower than 50%, the aquatic venue is susceptible to evaporation and heat loss, which would increase heating, water treatment, and water replenishment costs.

4.2.2.2.1 Cold Weather

Paints suitable for use as vapor retarders usually have high solids and must be carefully applied to achieve a rating of 0.4 perm for one coat. It is important to get very good coverage without gaps or thin spots. The paint supplier or manufacturer should be consulted for ratings and BEST PRACTICES.

4.2.2.2.2 Paint or Coating

The EPA states that there are three main ways to ensure good indoor air quality – ventilation, filtration, and source control. Ventilation and filtration are handled in Section 4.6.2 of the MAHC, but source control is also important. Many man-made products produce volatile organic compound *(VOC)* emissions and numerous studies have proven their potentially detrimental impact on human health. These potentially harmful emissions can be off-gassed from many products, including wet applied products *(paints, coatings, adhesives, sealants)*. This section is intended to set minimum requirements for limiting off gassing of VOC from paints and coatings that could cause public health impact during and after the application of these products. (https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality). One U.S. perm equals 1.0 grain of moisture per square foot per hour per inch-of-mercury differential pressure. One U.S. perm equals 57 SI perm.

4.2.2.3 Mechanical Systems

4.2.2.3.3 Indoor Aquatic Facility Air Pressure

Air-pressure-supported INDOOR AQUATIC FACILITIES might require pressurization of adjoining or connected spaces.

4.2.2.3.4 Air Ducts

Refer to the ASHRAE Handbook of HVAC Applications on Natatorium Design for recommendations. Coated steel, aluminum, and fabric ducts might be options to consider.

4.2.2.3.4.1 Insulated Duct

The duct should be insulated if it is located in an area where the design dewpoint of the space is above the design air temperature of the ducted air.

4.2.2.4 Indoor Aquatic Facility Doors

Where exterior doors of an INDOOR AQUATIC FACILITY might be exposed to temperatures below the freezing temperature of water, the frames should be constructed to minimize the risk of the door freezing closed. The issue here is one of emergency exit. There is a large amount of water vapor available to freeze into the gap between doors, etc., that can inhibit emergency exiting. Exception: Other doors should be acceptable, subject to approval by the AHJ, where heating systems are so arranged as to maintain such doors at least 5°F *(-15°C)* above the freezing temperature of water.

4.2.2.4.5 Automatic Door Closer

It is a critical SAFETY issue that a door both closes completely and latches to prevent young unsupervised children from accessing the AQUATIC FACILITY or AQUATIC VENUE.

4.2.2.5 Indoor Aquatic Facility Windows

Windows are usually maintained above -air dew point to prevent condensation and mold growth by heated supply air flowing over them. Heavy window frames on the interior side interfere with the proper flow of this heated air by the Coanda effect *(a corollary of Bernoulli's principle)*. There are many ways to mechanically address window condensation issues. Air supply can be dumped on glazing from both above and below. Fin tube heaters have also been effectively employed along sills in many instances.

Also see: ASHRAE Handbook of Fundamentals[62]

4.3 Equipment Standards

4.4 Aquatic Facility and Venue Operation Maintenance

4.5 Aquatic Venue Structure

4.5.1 Design for Risk Management

Working with the owner or aquatic risk management consultant, the designer can outline the anticipated zones of PATRON surveillance and place fixed lifeguard stations accordingly. It is important to have a person knowledgeable in aquatic risk management to advise on placement of fixed lifeguard stations and the general design of the AQUATIC VENUE as it relates to placement of lifeguards so to avoid blind spots, glare issues, and other obstructions being included in the design. This also allows the owner to influence design, so it meets the anticipated labor requirements. In some operations where the AQUATIC VENUE design requires more lifeguards, this puts pressure on owners to minimize labor by extending zones of PATRON surveillance. Small design changes could reduce zone size without taking away from PATRON enjoyment. This is also a critical need when considering alterations such as the addition of new AQUATIC FEATURES *(e.g., WATERSLIDES, mushroom)* that change visibility and, consequently, the PATRON zones of surveillance and increase the number of lifeguards needed. This knowledge is important to have while deciding on the benefits of the new AQUATIC FEATURE so they can be balanced with the increased labor cost.

4.5.2 Bottom Slope

4.5.2.1 Under Five Feet

A maximum slope of 1:12 is used in water under 5 feet *(1.5 m)* for consistency with ADAAG since these ramps can be used for access. Variances may be considered by the AHJ.

4.5.2.3 Drain

POOLS should be designed to allow for the water to drain to a low point to prevent standing water from creating a contamination issue.

4.5.3 Pool Access / Egress

4.5.3.1 Accessibility

As required by the Department of Justice, all POOL designs shall be compliant with the Americans with Disabilities Act Accessibility Guidelines *(ADAAG)*. The POOL design shall not create SAFETY hazards with regards to maintaining necessary clearances, not infringing upon the recirculation of AQUATIC VENUE water, or creating areas for potential entrapment.

4.5.4 Stairs

4.5.4.3 Deep Water

It is common, especially in high-end diving wells with ten-meter towers, for there to be "swim-out" stairs underneath the dive tower. This provision is allowing for those types of deep-water stairs without requiring the stairs to continue down to the bottom of the POOL *(which might be 17 feet deep and impractical in the diving well example)*.

4.5.4.8 Perimeter Gutter Systems

It is not the intent of this section to eliminate the "roll out gutter" as they need to be a minimum 6 inches *(15.2 cm)* from DECK to water level.

4.5.5 Handrails

4.5.5.3 Upper Railing

The 28-inch *(71.1 cm)* minimum might seem inconsistent with ADAAG. However, most handrails at POOLS are not used for ADAAG accessibility. If railings are provided for ADAAG purposes, they will need to meet the ADAAG 34-inch *(86.4 cm)* STANDARDS. The current MAHC language stipulates that 28 inches *(71.1 cm)* is a minimum, which does not preclude a designer from using 34-inch *(86.4 cm)* railings.

4.5.5.5 ADAAG Accessibility

In addition to meeting ADAAG criteria *(e.g., height, spacing)*, the MAHC contains other necessary design criteria for handrails *(e.g., support, transfer loads)*. In the end, ADAAG STANDARDS will always take precedence over anything in the MAHC. Another source for guidance is the *Architectural BARRIER'S Guide* – refer to Swimming POOLS, WADING POOLS, and SPAS section numbers 242 and 1009.

4.5.5.7 Dimensions

Dimensions of handrails should conform to requirements of MAHC Code Table 4.5.5.7 and MAHC Figure 4.5.5.7.1. Federal ADAAG requires that top gripping surfaces of handrails shall be 34 inches minimum and 38 inches maximum vertically above stair nosings.

4.5.6 Grab Rails

4.5.7 Recessed Steps

4.5.8 Ladders

4.5.8.1 General Guidelines for Ladders

4.5.8.2 Ladder Handrails

ADAAG Accessibility

This pertains to the handrail comments in MAHC Annex 4.5.5.5. The MAHC does not intend to choose only certain aspects of ADAAG to enforce; the MAHC intends that all components of the current ADAAG requirements will stand irrespective of the MAHC language. However, ADAAG does not address structural requirements.

4.5.8.2.4 Pool Wall

This is a design criterion for POOLS in some of the western states. The initial intent was to design against entrapment between the railing and the POOL wall — both for fingers and the hands/wrists/arms of smaller children. CPSC recommends 4 inches *(10.2 cm)* based on child anthropometry tables. Anthropometric charts were reviewed in establishing the current allowable range.

4.5.8.2.5 Support

The structural requirements in the ladder, handrail, railing section are taken from commercial manufacturers and their recommended data.

4.5.9 Zero Depth (Sloped) Entries

4.5.10 Disabled Access

4.5.10.1 Conform to ADAAG Standards

Please refer to the U.S. Access Board website at www.access-board.gov.

4.5.11 Color and Finish

4.5.11.1 White or Light Pastel

POOL floors and walls should be white or light pastel in color such that the following items can be identified from the POOL DECK:

- Person or body submerged in the water,
- Algae growth,
- Debris or dirt within the POOL, and
- CRACKS in surface finish of the POOL.

The term "light pastel color" should be consistent with Munsell color value 6.5 or higher.

School, facility, or team logos incorporated on the POOL finishes are acceptable but will require review by the AHJ to ensure the design of such logos do not impede the color and finish functionality listed above.

Ultimately, water clarity is the primary criteria with which to be concerned.

4.5.11.1.1 Munsell Color Value

The State of Wisconsin uses the Munsell color chart and requires values of 6.5 or greater. The Munsell color system looks at color purity, hue, and lightness to assign a value. This system is used in other industries and information on this system is easily available.

A contractor could provide a mock-up during the submittal process to the AHJ or engineer for review and approval. Plaster and other quartz aggregate manufacturers have reflectance testing that is available for finish samples.

The American Plasterer's Council defers to ASTM E1477 – 98a to determine LRV values. It's a test method where "Test specimens are measured for *(total)* luminous reflectance factor by STANDARD color-measurement techniques using a spectrophotometer, tristimulus *(filter)* colorimeter, or other reflectometer having a hemispherical optical measuring system, such as an integrating sphere." The specular component is included to provide the total reflectance factor condition. The instrument STANDARD is referenced to the perfect reflecting diffuser. Luminous reflectance factor is calculated as CIE tristimulus value Y for the CIE 1964 *(10°)* STANDARD observer and CIE STANDARD illuminant D 65 *(daylight)* or F 2 *(cool white fluorescent)*.

4.5.12 Walls

4.5.12.4 No Protrusions, Extensions, Means of Entanglement, or Obstructions

There should be no projections from a POOL wall that could cause BATHER entrapment or injury. Exceptions to this include projections including, but not limited to, structures or elements such as stairs, grab rails, ladders, hand holds, PENINSULAS, WING WALLS, underwater lights, SAFETY ROPE AND FLOAT, WATERSLIDES, play AQUATIC FEATURES, other approved POOL amenities, UNDERWATER BENCHES, and UNDERWATER LEDGES.

4.5.13 Structural Stability

Expansion or CONSTRUCTION JOINTS should be utilized when determined prudent by a licensed structural engineer. Any joints should utilize waterproofing strategies such as water stops as they are subject to compromising a POOL's integrity regarding water tightness. The condition of all joints should be inspected regularly to ensure their condition.

4.5.14 Hand Holds

Based on anthropometric data for children ages 6.5–7.5 years, the difference between their stature and vertical grip reach averages 9.3 inches *(23.6 cm)* so this measurement is incorporated as 9 inches *(22.9 cm)*.

4.5.15 Infinity Edges

4.5.15.1 Perimeter Restrictions

Often with INFINITY EDGE POOLS, the space immediately on the other side of the INFINITY EDGE is an inaccessible area because the DECK needs to end to achieve the "infinity" effect—typically this is achieved by an elevation difference—the DECK continues to extend around the POOL perimeter, but below the edge. The MAHC goal was to allow these types of design features while ensuring that these areas of the POOL are safe and still readily accessible for emergency response.

4.5.15.3 Handholds

INFINITY EDGES can be accomplished with an obtuse angle or knife edge, or even a C701 handhold. It is typically submerged a fraction of an inch.

4.5.15.6 Maximum Height

Building CODEs typically require a railing for heights greater than 30 inches *(76.2 cm)* for SAFETY purposes.

4.5.16 Underwater Benches

UNDERWATER BENCHES are intended to allow BATHERS to sit in locations along the POOL wall. These chair/bench-like structures either protrude into the POOL from the POOL wall or are recessed into the POOL wall. To accommodate the size of most people, the seat itself is often 16 inches *(40.6 cm)* to 18 inches *(45.7 cm)* wide and is located 12 inches *(30.5 cm)* to 20 inches *(50.8 cm)* below the water line. Use of hydrotherapy jets along UNDERWATER BENCHES should be considered during the design phase. Where hydrotherapy jets are used at UNDERWATER BENCHES in swimming POOLS, they could potentially push young children from benches, prevent young and weak swimmers from reaching the handhold at the perimeter of the POOL in the location of the bench, or could impart motion to an unconscious victim making it more difficult to identify a victim in need of rescue. This could increase risk of drowning particularly for small children not being supervised. In addition, air entrained by hydrotherapy jets obscures visibility below the water surface which can prevent recognition of a victim submerged below the water surface. More data would help assess this potential risk.

4.5.16.1 Slip-Resistant

SLIP-RESISTANT surfaces shall meet or exceed the minimum coefficient of friction as set forth by the following groups:

- American National Standards Institute *(ANSI)* designated Standard
- Americans with Disabilities Act Accessibility Guidance *(ADAAG)*
- Occupational Safety and Health Administration *(OSHA)*

4.5.16.3 Maximum Water Depth

The 5-foot *(1.5 m)* depth restriction is to address the potential SAFETY issue of stepping or otherwise moving off a bench into deep water. The seat depth below the water line is limited to 20 inches *(50.8 cm)* maximum so a non-swimmer might be comfortable at that depth but once they move from the bench into a greater water depth it might exceed their comfort or skill level.

4.5.17 Underwater Ledges

4.5.17.1 Slip-Resistant

An UNDERWATER TOE LEDGE for resting *("tired swimmer's ledge")* might be appropriate in any POOL with water depths greater than 5 feet *(1.5 m)*. An UNDERWATER TOE LEDGE might be provided at the deep end of a competition POOL or other POOL with swim lanes. A ledge for resting might also be provided along the sidewalls of the same POOLS to allow swimmers, who are using the POOL for recreational swimming, to rest.

4.5.17.3 Five Feet or Greater

A ledge for resting should not allow a person to use the ledge to cross from a shallow area into a deeper area of a POOL.

4.5.17.4 Structural Support

UNDERWATER LEDGES for structural support for an upper wall *(structural ledge)* are often located at a water depth of about 3 feet *(0.9 m)* depending on the wall manufacturer. The upper wall is a product manufactured of stainless steel, fiberglass, acrylic, or other materials. The support ledge and wall below the ledge is concrete, gunite, or other materials that the wall manufacturer specifies. Although POOLS using this wall structure are generally smaller POOLS, these POOLS can be any depth.

4.5.18 Underwater Shelves

Underwater shelves can be areas such as an expanded top tread of a stairway or a separate area many feet wide and long. The main purpose is for lounging in very shallow water, in chairs, or contoured as couches.

4.5.19 Depth Markers and Markings

4.5.19.1 Location

4.5.19.1.2 Depth Measurements

Non-traditional AQUATIC VENUES such as ACTIVITY POOLS and LAZY RIVERS might have designated entry and exit points and are generally consistent in depth throughout the AQUATIC VENUES. Other AQUATIC VENUES might have landscaping or other BARRIERS so that there is a defined entry such as in a LAZY RIVER. AQUATIC VENUES should install depth markers on the AQUATIC VENUE wall or, when defined entry points are provided, post the depth on entry signs. This requirement is not intended to apply to competition AQUATIC VENUES where skilled divers train and compete in 4–6 feet *(1.2–1.8 m)* of water and are under the supervision of a certified instructor or coach.

4.5.19.1.3 Below Handhold

Vertical depth markings should be provided just below the handhold for POOLS with DECK level gutters. They could also be considered on the wall of the INDOOR AQUATIC FACILITY if within a reasonable distance from the POOL. For DECK level gutter POOLS, vertical depth markings are more visible just below the water level when compared with locating them on a building wall or fence which might be 10 feet *(3 m)* to 50 feet *(15.2 m)* away and obstructed by DECK equipment, POOL appurtenances, etc.

4.5.19.2 Construction / Size

4.5.19.2.3 Color and Height

Depth markers 4 inches *(10.2 cm)* in height are common among several state CODES and found in ANSI/IAF-9 and ANSI/APSP/ICC-1 2014. Also, Human Factors Standards recommends 1 inch *(2.5 cm)* of letter height to ten feet *(3.0 m)* of viewing distance for oversized letters or 1 inch *(2.5 cm)* of letter height to 16.6 feet *(5.1 m)* which is ideal. A 1-inch *(2.5 cm)* letter height to 30 feet *(9.1 m)* of viewing distance is the minimum.

4.5.19.2.4 Feet and Inches

Some states might require both units of measurement in feet, inches, and meters. Some states do not allow for abbreviation of units. Designers may consider using both units of measure on POOLS since thousands and possibly millions of travelers and immigrants enjoy water recreation facilities in the United States. Travelers and new immigrants might not be familiar with imperial measurements such as feet and inches, especially those who come from non-English speaking countries. As a result, those individuals don't have a clear understanding of the length of a foot and therefore might not realize how deep the water is with imperial depth markings—this is essential knowledge for drowning prevention.

4.5.19.4 No Diving Markers

4.5.19.4.1 Depths

The symbol is required as it is the universally recognized symbol for "No Diving" and can be understood by those who do not read and non-English speaking individuals. Diving boards are permitted only when the diving envelope conforms to the STANDARDS of the certifying agency that regulates diving at the facility - NCAA, NFHS, WORLD AQUATICS, or USA Diving. If the AQUATIC VENUE does not have competitive diving, then the diving envelope must conform to these diving envelope STANDARDS. The intent of this section is to prohibit recreational or unsupervised users from performing DECK level diving into water 5 feet *(1.5 m)* or shallower. It is not intended to apply to competitive divers competing under the auspices of an aquatics governing body *(e.g., WORLD AQUATICS, USA Swimming, NCAA, NFHS, YMCA)* or under the supervision of a coach or instructor. The vast majority of current STANDARDS allow for diving off the side of the POOL in water 5 feet *(1.5 m)* deep or greater. Water depths of at least 5 feet *(1.5 m)* are generally considered as safe for diving from the edge of a POOL where the coping/DECK is the typical 6 inches *(150 mm)* above the water surface. AQUATIC VENUE size and geometry might necessitate additional depth marking placements about all sides of the AQUATIC VENUE. The ARC recommends 9 feet *(2.7 m)* of water depth based on analyses of spinal cord injuries[63]. The organization has clarified this recommendation to state, "Be sure water is at least nine-feet deep unless performed with proper supervision and in water depths that conform with the rules of the concerned regulating body, such as USA Swimming, NCAA, AAU, NFHS, YMCA of the USA, and WORLD AQUATICS." Although there are some national data on spinal cord injuries *(SCIs)* in general, data on diving-specific SCIs are limited, particularly for SCIs involving public POOL-related competition diving.

General data on spinal cord injuries: For SCIs in general, approximately 40 SCIs/million population occur each year in the US *(about 12,400 injuries for 2010)* with approximately 4.5% related to diving injuries[64]. SCIs are a catastrophic public health problem leading to disability and decreased life expectancy with a large economic and social burden for those that suffer the injury.[65, 66] The MAHC recommends that these national data be re-analyzed with aquatics in mind to gather more detailed information on SCIs related to diving in AQUATIC VENUES, particularly public AQUATIC VENUES.

DECK level diving and swimming POOL-related SCIs: Most SCIs are related to diving into open water *(lakes, ocean)*[67] or use of private/residential POOLS. Analysis of the National Spinal Cord Injury Statistical Center data shows that 341 enrollees from 1973–1986 had an SCI as a result of diving into swimming POOLS[68]. Almost all of the injuries *(87%)* resulted from diving into private residential POOLS and 57% of injuries were a result of diving into water less than 4 feet *(1.2 m)* with almost four out of five dives *(76.8%)* being DECK level dives. Almost half *(49%)* of injuries involved alcohol use and 46% occurred during parties. In a summary of 194 neck injuries from DECK level dives into in-ground POOLS *(33% private residential)*[69] 86.6% were in water less than or equal to 4 feet *(1.2 m)*; 99.0% were in water less than or equal to 5 feet *(1.5 m)*. Only one injury occurred in water 6–7 feet *(1.8 to 2.1 m)*. Another global review study showed that 89% of diving-associated neck injuries occurred in water less than 5 feet[64]. These data support keeping non-competition DECK level diving to water depths greater than 5 feet *(1.5 m)*. In a study of U.S ED data from 2006–2014, an estimated 83,000 ED visits for injuries occurred because of diving into swimming POOLS. The majority were male and significantly more patients were in the 15–24 year age category. Spinal cord injuries were more common in those older than 25 years, whereas intracranial injuries occurred more frequently in younger patients. The total charges for the 6-year period approached $620 million[70].

International No Diving Marker Example: Figure 4.5.19.4.1.1

Also see: *ANSI/NEMA Z535*: Safety Alerting Standards

4.5.19.5 Depth Marking at Break in Floor Slope

A contrasting band is required at the slope transition between shallow water and deep water as an additional means of caution *(along with the SAFETY ROPE AND FLOAT and warning signage)* to BATHERS.

4.5.19.6 Dual Marking System

An example would be an AQUATIC VENUE design, which can be circular in nature, where there is a shallow end around the entire perimeter and the bottom slopes from the perimeter towards a deeper portion in the center.

4.5.19.8 Wading Pool Depth Markers

A WATERSLIDE run-out in a WADING POOL may hold up to 6 inches *(15.2 cm)* of water without necessitating a no-diving sign or depth marker.

4.5.20 Aquatic Venue Shell Maintenance

4.5.21 Special Use Aquatic Venues

Since the development of the MAHC, SURF POOLS were identified as different from WAVE POOLS, and many of the requirements for MAHC 4.0: Design and Construction are not applicable to SURF POOLS. The term SPECIAL USE AQUATIC VENUE has been added to potentially allow construction and use of SURF POOLS and any other, yet to be identified, AQUATIC VENUE or POOL that, while meeting the intent of CODE applicability to public AQUATIC FACILITIES, cannot practically be designed to meet existing design STANDARDS and keep the intended use. It is anticipated that appropriate design STANDARDS will be developed and incorporated in the CODE as part of the MAHC revision process.

There are three types of SURF POOL systems currently available or being developed.

- Sheet flow – this sheet of water typically 1.5 inch *(3.8 cm)* thick moving at a high velocity (e.g., FlowRider).
- Thick flow – a deeper section of water typically 8 *(20.3 cm)* – 14 inches *(35.6 cm)* flowing at a medium velocity *(e.g., Surfstream)*.
- SURF POOL – large 20,000 to 80,000 square feet (1,858 to 7,432 m^2) POOLS with reefs intended to produce surfable waves. Wave systems range in design from a flying reef *(e.g., Wavegarden)* to pneumatic or hydraulic systems *(e.g., Typhoon Lagoon)*. SURF POOLS built just for surfing are

intended for only a few riders at once and can have complex wave dampening systems on the walls and in shallow water.

4.6 Indoor / Outdoor Environment

4.6.1 Lighting

4.6.1.2 Windows / Natural Light

This would most likely be achieved using photo sensors that would be triggered by a pre-established minimum light level. Manual controls would almost certainly be set based on time of day. As the amount of daylight fluctuates throughout the year, these would need to be adjusted.

4.6.1.3 Light Levels

The minimum light levels are as recommended in the IES RP-6-15, "Sports and Recreational Area Lighting" for the recreational class of use. Higher light levels are recommended for various competitive classes of use. Higher levels may be advisable for acceptable spectator viewing for competitive swimming and diving events. There is a difference between indoor and outdoor settings because outdoor settings usually have a higher contrast with darkness that does not occur indoors.

4.6.1.4 Overhead Lighting

Avoid glare by keeping overhead lighting directed 60-90 degrees horizontal of the eye. Glare on water can be avoided by direct lighting *(i.e., the more direct the light, the less opportunity for glare)*. Also consider maintaining a close ratio of the lighting underwater and overhead to obtain a balance thus avoiding glare.

4.6.1.4.1 Artificial Lighting

Avoid glare from artificial light that interferes with the lifeguard's view of the swimmers.

4.6.1.5 Underwater Lighting

Current regulations specify an under-water light level equivalent to ½ watt per square foot of AQUATIC VENUE surface area. This value is based on outdated incandescent lighting technology. For today's light sources for higher-efficiency lamps *(i.e., more light output per watt)*, this requirement no longer makes sense. Consider using a measure of light output *(e.g., lumens)* instead. Based on an existing 300W General Electric R40 AQUATIC VENUE lamp that produces 3,750 initial lumens of light output, the conversion between watts and lumens is as follows:

0.5 watts/sq.ft. x 3,750 lumens/300 watts = 6.25 lumens/sq.ft.

Example:

Lighting comparison between Incandescent & LED lamps for a 2,400 square foot *(223 m^2)* AQUATIC VENUE.

- 300-watt Incandescent Lamps (12.5 lumens per watt = 3,750 lumens per lamp)
  - 2,400 square feet x 0.5 watts/square foot x lamp/300watts = 4 lamps
- 30-watt LED Lamps (125 lumens per watt = 3,750 lumens per lamp)
  - 2,400 square feet x 6.25 lumens/square foot x lamp/3,750 lumens = 4 lamps

Notice that LED lamps are 90% more efficient *(lumens/watt)* than Incandescent lamps.

"A replacement lamp will need to provide 6.25 lumens per square foot of surface area."

Additional Information: The incandescent lamp has an average life of 2,000 hours. For an AQUATIC VENUE that is operational 12 hours per day for 365 days *(4,380 hours per year)*, the incandescent lamp failure rate would be approximately two times a year. Note that in-water AQUATIC VENUE lighting remains on when the AQUATIC VENUE is closed to swimming. For the 50,000-hour life of an LED lamp, the failure rate would be 11.4 years. The AQUATIC VENUE surface replacement would be a determination of replacement lamps and not the lamp itself. Annual energy savings per lamp would be 1,183 KWH.

4.6.1.5.1 Minimum Requirement

A common practice has been to express underwater lighting requirements in watts per square foot of POOL surface. Light output efficacy *(lumens per watt)* can vary greatly depending on the light source. Incandescent lighting, the most historically prevalent underwater light source, also has the lowest or worst efficacy. Some of the most common incandescent lamps are listed below, along with their initial lumen output and calculated efficacy.

Table 4.6.1.5.1: Common Incandescent Lamps and Their Initial Lumen Output and Efficacy

Lamp	Initial Lumens	Efficacy *(Lumens/Watt)*
200-Watt PAR 46	*2270*	11.35
200-Watt PAR 56	*2270*	11.35
300-Watt PAR 56	3840	12.80
500-Watt PAR 64	6500	13.00

For the purposes of these requirements, the underwater lighting requirements have been converted from incandescent watt equivalents to initial lamp lumens using a conversion factor of 12.0 lumens per watt. The converted watts per square foot of POOL surface requirements are 0.5 watts *[outdoor]*, 1.5 watts *[indoor]*, 1.5 watts *[outdoor-diving]*, 2.5 watts [indoor-diving]. White lighting is best for illuminating underwater surfaces for the detection of a swimmer. Colored lighting makes it more difficult to distinguish a body underwater. Designers should discuss output requirements with manufacturers when considering colored lighting since colored lights might not deliver the same illumination levels as white lights and might, therefore, not meet MAHC requirements. It is recommended that future studies be conducted to determine minimum lighting requirements based on water depth, hours of operation, and overhead lighting design. The main goal is to be able to see the bottom of the POOL, in particular a person on the bottom, at all times when the POOL is open to the public.

4.6.1.6 Night Swimming with No Underwater Lights

Providing higher lighting levels *(15 footcandles (161 lux))* than the minimum requirements *(10 footcandles (108 lux))* of MAHC 4.6.1.3 eliminates the requirement for underwater lighting in outdoor POOLS.

4.6.1.7 Emergency Lighting

This section isn't intended to provide less stringent requirements, just a baseline STANDARD of design for locales that might not address this requirement. The industry commonly uses 0.5 foot-candle *(5.4 lux)* as an industry design STANDARD.

4.6.1.8 Glare

Consider the sun's positioning through different seasons as well as the window placement to avoid glare. Consider moveable lifeguard stands or positions to avoid glare in different seasons. Consider tint and shades when natural light causes glare. Windows and any other features providing natural light into the POOL space and overhead POOL lighting should be arranged to avoid glare on the POOL surface that would prevent identification of objects on the POOL bottom. Careful consideration should be given to the placement of windows and skylights about the POOL. Natural light from directly overhead is less likely to create glare than light through windows at the sides and ends of the POOL. Control of glare from artificial light is more likely if the angle of incidence of the main light beam is less than 50 degrees from straight down. Diffuse or indirect light sources might also help to minimize glare. The MAHC had a very difficult time coming to a consensus on wording regarding glare that could be defended and enforced from a regulatory standpoint. How does a plan reviewer determine that glare based on design documents are excessive (perhaps only in certain months of the year)? The MAHC decided to put design recommendations would best be addressed in the Annex.

4.6.2 Indoor Aquatic Facility Ventilation

Background of Ventilation and Air Quality Technical Committee Work on the MAHC

Numerous local and state health *CODES (N=28)* plus NEHA recommendations regarding ventilation were reviewed prior to the release of the 2014 MAHC (1st Edition). The MAHC found that:

- Most addressed only moisture control.
- The terms used were sometimes vague with 11 *(39%)* of the 28 CODES having very general language typically stating "adequate" or "proper" ventilation without clear definitions of these terms;
- Three *(11%)* CODES and NEHA specify compliance with ASHRAE Standards;
- Most refer to their state or local ventilation or mechanical CODE for compliance requirements; and
- Five *(18%)* have developed other state-specific criteria for air TURNOVER and exchange.

As a result of this varied and sometimes vague approach to defining "proper" ventilation, it is critical that the MAHC begins to better define AIR HANDLING SYSTEMS and establish parameters for air quality that reduces the risk of potential health effects. The aquatics sector has always had a challenge with indoor air quality. With the popularity of large BATHER capacity indoor aquatic venues —indoor air quality is an increasingly important public health concern. Although the AIR HANDLING SYSTEMS of these AQUATIC FACILITIES are quite sophisticated, there are many variables to consider. The use of water features can promote the transfer of volatile compounds from water into the air and should be accounted for in the management of indoor air quality. In addition, much research is still needed in water chemistry and the use of other technologies to improve indoor air quality. The MAHC outlines the design, performance, and operational parameters that can be detailed using data available at the current time. The Annex information provides insight into the Ventilation and Air Quality Technical Committee's rationale during MAHC development and also identifies areas where more research is needed before additional parameters can be set. The MAHC's intent is to require the design of an INDOOR AQUATIC FACILITY to be conducted by a licensed professional engineer with experience in the design of mechanical systems as well as expertise related to water chemistry and gas:liquid transfer processes. The MAHC approached this section assuming designs will be evaluated by the AHJ in the location in which the system is to be installed. Following the first public comment period during MAHC development, the ventilation requirements were dramatically changed, and draft material was removed from both the Code and Annex. The thinking behind those initial recommendations was saved for future consideration in MAHC, Appendix 2.

4.6.2.1 Purpose

The purpose of the AIR HANDLING SYSTEM is to assure the health and comfort of the users of the AQUATIC FACILITY. A variety of health effects can occur as a result of poor ventilation that leads to accumulation of chemical and biological products in the air as well as detrimental effects on infrastructure such as corrosion. The following section reviews some of the issues of concern for INDOOR AQUATIC FACILITIES.

Disinfection Byproducts

The OXIDATION of waterborne organic and inorganic compounds by CHLORINE- or other halogen-based products is a complex process leading to creation of a large number of OXIDATION and DBPs during the drinking water and aquatic water treatment processes. The source of these compounds is variable but includes source water CONTAMINANTS, BATHER waste *(e.g., feces, urine, sweat, skin cells)*, and environmental introductions *(e.g., dirt)*. Although the identity of many of these compounds is known, many others are uncharacterized, and the health effects associated with short- and long-term exposure to these compounds are only just starting to be characterized for the aquatic environment. Several of these compounds are known to be volatile and can accumulate in the air surrounding an indoor AQUATIC VENUE. Multiple reviews discuss the acute and potentially long-term health effects *(e.g., asthma, bladder cancer)* of exposure to these compounds in the aquatic setting since many of the studies are cross-sectional or ecologic in design, which precludes establishing causation *(e.g., by exposures such as swimming)*.[11, 12, 45-47, 71, 72] The nitrogenous OXIDATION by-products DICHLORAMINE and TRICHLORAMINE *(e.g., chloramines)* are known to be irritants that cause acute eye and lung distress. Accumulation of these compounds in indoor settings has been previously documented in several occupational settings where workers routinely use chlorinated solutions to rinse organic products such as poultry[73, 74] and raw produce[75]. Similar symptoms of ocular and respiratory distress have been documented in outbreaks associated with use of INDOOR AQUATIC FACILITIES.[27-32] Other suspected chloramine-associated outbreaks are listed in past issues of CDC's Surveillance Reports for Recreation Water–associated Diseases & Outbreaks, which can be viewed at

www.cdc.gov/healthywater/surveillance/rec-water-surveillance-reports.html. Also see MAHC Annex 4.0.1.4.7.

Biological Byproducts

A variety of biological organisms that grow naturally in the environment (e.g., *Legionella, Mycobacterium avium complex,* other non-tuberculous mycobacteria, and gram negative bacteria *[which release endotoxins upon death or breaking down of cell membrane])* or their constituents *(e.g., proteins, lipo-polysaccharides, endotoxin)* can be spread in the INDOOR AQUATIC FACILITY environment and cause infections[76, 77] and hypersensitivity/allergic reactions *(e.g., "Hot tub lung," "Lifeguard lung," Pontiac fever)*.[78-82] The pathogens and their constituents can be minimized with adequate INDOOR AQUATIC FACILITY ventilation, maintenance, and required water quality.

4.6.2.2 Exemptions

For purposes of the MAHC, only "buildings" as defined in the building CODE is considered to be included in the scope of the INDOOR AQUATIC FACILITY definition since there are many variables to consider for places like open buildings *(might not have a roof or missing sides)* such as variations in weather, geographic zone, etc. that would impact AIR HANDLING SYSTEM design or if one was needed. The guidelines in this module are meant to address the SAFETY and health of users in environments in which air quality is managed by mechanical means due to the "closed" environment.

4.6.2.5 ASHRAE 62.1 Compliance

The hierarchy of design was important in deciding what priorities were taken in the development of the design section. The following hierarchy was determined by the MAHC:

- Indoor air quality - chemical, biological, and physical CONTAMINANT load
- Moisture removal – humidity and temperature
- Cost of energy – important to larger sites

When determining the factors a DESIGN PROFESSIONAL considers, much discussion centered around ASHRAE 62.1 and the parts of design not specifically listed in ASHRAE 62.1 as it applies to INDOOR AQUATIC FACILITIES. There are two SAFETY functions of the AIR HANDLING SYSTEM: to bring in fresh air and to protect the PATRONS and the building, which requires movement of air. The current ASHRAE 62.1 Standard states 0.48 cfm/ft^2 fresh air is the minimum air change. The MAHC considers AIR DELIVERY RATE like TURNOVER for AQUATIC VENUES. To ensure good indoor air quality, it is likely that the design should consider THEORETICAL PEAK OCCUPANCY, water type *(e.g., flat, agitated, hot)* and the size and use of the building. The current STANDARDS approach to ventilation is based on square footage of the AQUATIC FACILITY and yet AQUATIC FACILITIES vary in size. Some facilities have a 20-foot *(6.1 m)* ceiling and in the case of indoor waterparks and stadium-style INDOOR AQUATIC FACILITIES, the ceiling heights can reach 60+ feet *(18.3 m)*. In addition, the water surface area has a great deal to do with the amount of CONTAMINANTS released into the air but this is generally not included in design criteria. There are many microclimates in larger AQUATIC FACILITIES with varied AQUATIC VENUES and AQUATIC FEATURES. Air movement will need to be targeted within these microclimates. The challenge is that ASHRAE 62.1 only considers the building square footage and number of spectators rather than BATHERS. ASHRAE fundamentals require an AIR DELIVERY RATE for the volume of air. Designers felt water chemistry, fresh air, THEORETICAL PEAK OCCUPANCY, water surface area and type, and distribution of air *(barring condensation)* are more or equally as important as the AIR DELIVERY RATE. Additionally, the number and type of BATHERS and the use of water features may also be impactful on air quality and should be accounted for during the system design process.

4.6.2.6 Indoor Air Quality Control

4.6.2.6.2 Design Factors and Performance Requirements

Known chemical, biological, and physical CONTAMINANTS:

The MAHC discussed the various chemical and biological CONTAMINANTS, the availability of testing protocols, and data to support developing health effect thresholds.

Table 4.6.2.6.2: Known Chemical, Biological, and Physical Contaminants:

Chemical	Biological
Trichloramines	*Mycobacterium avium* complex
Trihalomethanes	*Legionella* spp. (primarily *L. pneumophila*)
Other chlorinated compounds	Endotoxin
Carbon dioxide	

The researchers on the committee were able to provide a list of research regarding the thresholds of such CONTAMINANTS that produced symptoms in users of INDOOR AQUATIC FACILITIES. More detailed summaries of these data can be found in ***Appendix 1: Summary of Health and Exposure Data for Chemical and Biological Contaminants***. After evaluating possible CONTAMINANTS, the committee felt the most frequently detected adverse health symptoms associated with indoor air quality were related to chemical CONTAMINANTS. In evaluating the various chemical CONTAMINANTS, it was found that TRICHLORAMINE was the most prevalent CONTAMINANT reported[39]. Therefore, this section of the MAHC focused on TRICHLORAMINE as the major chemical CONTAMINANT for design considerations.

The bullets below summarize some of the findings on the threshold amounts that produced adverse health symptoms.

- Gagniere[83] 0.5 mg/m^3
- Levesque[84] 0.37 mg/m^3
- Hery[85] 0.5–0.7 mg/m^3
- Massin[86] 0.5 mg/m^3
- Jacobs[87] 0.56 mg/m^3 *(average)*
- Thickett[39] 0.5 mg/m^3

In evaluating the TRICHLORAMINE research, it was apparent there is not a single test method used throughout the research. Without a validated test method, it is difficult to compare and benchmark the data from the various studies. As a result, a firm threshold could not be determined solely on the published research. Also, without a validated and simple test method, there is not an easy way for health departments or owner/operators to test routinely or with any consistency. Although literature suggests a threshold of 0.5 mg/m3, for these two reasons, the MAHC could not establish a threshold to be enforced in the MAHC at this time. More research using a validated test method might lead to determination of a threshold concentration in the future. To enforce such a threshold concentration, the test also needs to be commercially available and easily performed by aquatics staff and health officials. Therefore, the performance requirements for the AIR HANDLING SYSTEM have parameters for fresh air and dew point/humidity.

To accomplish this, several design criteria were kept in mind:

- Fresh air requirements are established to specific concentrations. The theory is that if the building mechanical system can evacuate enough air to remove TRICHLORAMINE, then by default the other airborne CONTAMINANTS would also be evacuated.
- Dew point/humidity levels are set to avoid mold growth and damage to the building structure.

In the future, if a readily available, STANDARD air testing method for TRICHLORAMINE is developed and a TRICHLORAMINE or other CONTAMINANT threshold can be determined, then it is the recommendation that the MAHC adopt such an action threshold for air quality. Additionally, based on the air data threshold set, a threshold should also be re-evaluated or revised for COMBINED CHLORINE compounds in water to minimize production and off-gassing of the volatile chloramines. Although subjective and highly variable, in the interim, biomonitoring for TRICHLORAMINES may be accomplished by training POOL operators to be on alert for the distinctive chloramine odor and eye and lung irritation it causes. Since the odor threshold for TRICHLORAMINE is ~0.1 mg/m^3 and, as illustrated above, health symptoms start happening around 0.3-0.5 mg/m^3, odor MONITORING can generally work well as an early warning system. It was recognized by the MAHC that SECONDARY *TREATMENT (e.g., ozone, U.V.)* could help to reduce the amount of off-gassing of DBPs and therefore would need less volumes of outside air to dilute the concentration of these chemicals in

the air. Basic treatment includes the use of CHLORINE or bromine and STANDARD filtration and will require a certain amount of outside air per AQUATIC VENUE type. UV/Ozone or other technology that is used to aid in the reduction of DBPs could reduce the amount of outside air required. The efficacy of UV and ozone are well documented for their effect on biological CONTAMINANTS but the photochemistry taking place is a different reaction for DISINFECTION versus controlling COMBINED CHLORINE concentrations. Further research is needed to determine the effectiveness of UV and ozone on destroying DBPs or creating new DBPs before they can be considered in the design of an AIR HANDLING SYSTEM. Guidance is included in the MAHC for the use of UV and ozone for DISINFECTION. It is unknown at this time if the parameters for the equipment to achieve DISINFECTION will also result in the reduction of DBPs. The initial draft of the MAHC Ventilation and Air Quality Module included discussion of fresh air requirements for facilities utilizing UV and ozone, which allowed for a reduction in the amount of fresh air required for ventilation compared with basic water treatment. However, until the efficacy of these technologies in reducing DBP formation can be established, and parameters can be set in which any installation of these technologies can meet minimum requirements, we cannot include these technologies as a method to reduce fresh air requirements. Such information should be considered when efficacy data become available. For future development of minimum performance requirements for UV and ozone, one should consider dose as a function of concentration and contact time. Many systems are designed for full flow treatment but contact time is very limited. These minimum parameters might help to attain efficacy, but as noted, more research is required. Below are some proposed statements for use once system efficacy can be determined:

- The DESIGN PROFESSIONAL may reduce the amount of fresh air with the use of UV or ozone if the DESIGN PROFESSIONAL can demonstrate the efficacy of the system and have it validated by a third party. The system must achieve a X% reduction of TRICHLORAMINE in a single pass.
- The system must be designed to achieve at minimum, a UV dose of X at the highest and lowest flow rate the system would normally operate.
- UV systems must have a wavelength of 254 or 282 nanometers to reduce monochloramine, DICHLORAMINE, and TRICHLORAMINE.

Another concern is that although it is believed UV and ozone are effective at breaking down TRICHLORAMINE, we do not know its effect on the other CONTAMINANTS such as THMs. If one uses the assumption that using fresh air to evacuate TRICHLORAMINE will result in removing other airborne CONTAMINANTS, then one must also consider other chemical CONTAMINANTS. If one reduces the amount of fresh air because a SECONDARY TREATMENT is used to break down TRICHLORAMINE, it does not mean the other airborne CONTAMINANTS are also destroyed by the SECONDARY TREATMENT. The photochemistry might be different so efficacy may have to be determined for other compounds.

4.6.2.6.3 Other Air Handling Systems

Ventilation in Chemical Storage Spaces

The design for CHEMICAL STORAGE SPACE was included in the initial version of the MAHC Ventilation and Air Quality module AIR HANDLING SYSTEM design posted for public comment. It was removed in the revised indoor AIR HANDLING SYSTEM design area of the MAHC as part of revising the definition of an INDOOR AQUATIC FACILITY for which the AIR HANDLING SYSTEM does not include CHEMICAL STORAGE SPACE or other space outside the negative pressure zone around the AQUATIC VENUE. However, the building of an INDOOR AQUATIC FACILITY will still require consideration of the ventilation of CHEMICAL STORAGE SPACES using separate AIR HANDLING SYSTEMS, so the text has been moved to MAHC 4.9.2.

Space Heating

- Space heating should be available year-round.
- Space heating should not be disabled seasonally.

Exceptions may include:

- Space heating need not be provided during such times as the POOL might be drained completely, all AQUATIC FEATURES and other evaporative loads are disabled and drained, and the room relative humidity does not rise above the design range.

- Space heating might not be required if ventilation with outdoor air is sufficient to prevent room temperature from falling below the design range, and room relative humidity from rising above the design range.

Note: Not all space heaters CERTIFIED, LISTED, AND LABELED for heating INDOOR AQUATIC FACILITY air are CERTIFIED, LISTED, AND LABELED for installation in an INDOOR AQUATIC FACILITY. Combustion space heaters should not be installed in an INDOOR AQUATIC FACILITY unless the heater is rated for the atmosphere.

4.6.2.7 Performance Requirements for Air Handling Systems

4.6.2.7.1 Designed to Maintain

This evaporation formula from the ASHAE 2019 Applications Handbook allows the entry of the actual air velocity across the water surface.

4.6.2.7.2 Minimum Outdoor Air Requirements

During MAHC development, substantial numbers of public comments were received regarding the proposed increase, above ASHRAE 62.1 Standards of required outdoor air. The commenters noted that the requirements will result in increased costs for equipment and operation while lacking adequate data to support the increase. Based on the potential negative impact and the need for additional research and data to differentiate the causes and sources of indoor air quality problems on design criteria *(e.g., design, inappropriate operation, inadequate maintenance)*, the MAHC decided to defer to ASHRAE 62.1 outdoor air requirements in final versions of the MAHC. The MAHC preserved the work done by the Technical Committee by moving the proposed CODE language for additional outdoor air to Appendix 2: Air Quality Formula along with preserving the corresponding Annex discussion. A research agenda should be developed and should be a priority to better address the contributing factors to indoor air quality problems and the appropriate design and operational requirements needed to address those factors.

4.6.2.7.3 System Alarm

There are several methods to MONITOR the outside air portion of the AIR HANDLING SYSTEM to establish the volume of outside air being introduced into the AQUATIC FACILITY. A MONITORING station should be installed. In addition, it should be noted that a negative pressure must be maintained during all operating modes. This negative pressure must be set-up at the commission stage by the installing contractor or by means of automatic operation by the AIR HANDLING SYSTEM or Building Automation System.

4.6.2.7.7 Relative Humidity

Relative humidity is a ratio, expressed in percent, of the amount of atmospheric moisture present relative to the amount that would be present if the air were saturated. Since the amount of atmospheric moisture is dependent on temperature, relative humidity is a function of both moisture content and temperature. The QUALIFIED OPERATOR and inspection personnel should routinely MONITOR the relative humidity of the INDOOR AQUATIC FACILITY. Relative humidity levels should be MONITORED using a properly calibrated humidity meter, and it can fluctuate based upon a variety of factors, including occupancy and use of the INDOOR AQUATIC FACILITY, but a range of 40–60% can be accepted. Maintaining relative humidity within acceptable levels in the INDOOR AQUATIC FACILITY environment is important for a variety of reasons. Research has shown elevated relative humidity levels often coincide with mold growth, damage to building structures, BATHER discomfort, and inadequate ventilation. The engineer should pay particular attention when designing the AIR HANDLING SYSTEM to ensure relative humidity levels can be maintained below the recommended 60% when the INDOOR AQUATIC FACILITY is occupied. It may also be necessary to install properly calibrated and maintained, real-time, relative humidity MONITORING devices to ensure the mechanical system can react to changing conditions inside the INDOOR AQUATIC FACILITY.

For consideration in designing a facility structure, dew point is a better measure of absolute moisture levels. Dew point has a relationship with relative humidity. A high relative humidity indicates that the dew point is closer to the current air temperature. Relative humidity of 100% indicates the dew point is equal to the current temperature and that the air is maximally saturated with water. For human comfort factors, the maximum relative humidity has been specified for a very narrow range of indoor temperatures. For the building design,

dew point is a more important metric because the outdoor conditions can be over a very wide temperature range. The DESIGN PROFESSIONAL must be able to calculate the internal dew point for all building structure components to avoid condensation. Condensation occurs when the inside surface temperatures equal the dew point of the space. Using a properly calibrated instrument designed to measure relative humidity eliminates the complexity of calculating relative humidity by hand. It is important to collect a series of representative relative humidity measurements inside the INDOOR AQUATIC FACILITY. The building should be divided into representative areas if necessary, depending upon size and various AQUATIC FEATURES. Measurements should be taken from each occupied area. Measurements should be taken at DECK level and recorded. Taking an arithmetic average of measurements will provide an estimation of the relative humidity in the INDOOR AQUATIC FACILITY. This might require consultation with DESIGN PROFESSIONALS.

4.6.2.7.9 Disinfection Byproduct Removal

It is the MAHC's intent not to limit the development of new technologies. The efficacy of these technologies is not readily apparent. In the future, there is a hope that the CODE will allow for the DESIGN PROFESSIONAL to decrease the outside air requirements when secondary technology is used and prove the efficacy of the added technology. Other methods and technology for decreasing DBPs include:

- Ventilating surge tanks to remove off-gassing TRICHLORAMINE before the water re-enters the POOL area, and
- Use of a cooling tower to force water to off-gas TRICHLORAMINE before reintroducing water to the POOL area.

Low exhaust placed near AQUATIC VENUE surfaces such that they remove the highest concentration of airborne DBPs are effective to remove tri-chloramines from the breathing zone. Proper placement of exhaust return intakes, and supply air will promote better overall air movement and can successfully reduce total concentration of tri-chloramine below "odor" concentrations.

4.6.2.7.12 Purge

When an AQUATIC FACILITY has an event *(e.g., POOL is shocked)* that requires the introduction of a larger volume of outdoor air, the PURGE mode can be manually triggered to provide a flush of the INTERIOR SPACE. The intent is to run the AIR HANDLING SYSTEM at PURGE capacity until the CONTAMINANT causing odor, eye, or lung discomfort has dissipated to an acceptable level. The lack of an assay for airborne chloramines, means that "acceptable" is arbitrary and unenforceable since it relies on an operator assessment. When appropriate tests are available, the MAHC will set a numerical action threshold that would be enforceable.

4.6.2.7.13 Air Handling System Filters

Manufacturers/designers could consider developing/incorporating specialized solid phase *(e.g., activated carbon or other media)* chloramine removal air filtration as another means to sequester chloramines and potentially reduce fresh air requirements. However, such systems need to show proven efficacy. With new methods development, such systems could eventually be designed with sensors confirming that the COMBINED CHLORINE is at an acceptable concentration *(when such air measurement methods become available)*. If concentrations increased, then the AIR HANDLING SYSTEM could proportionally increase the amount of outside air.

Air Quality – Health

No rapid, simple, and commercially available tests for di- and tri-chloramine exist at the current time. However, MONITORING for TRICHLORAMINES may be accomplished by training POOL operators to be on alert for the distinctive chloramine odor and eye and lung irritation it causes. The odor threshold for TRICHLORAMINE is 0.1 mg/m^3 and health symptoms start happening around 0.3–0.5 mg/m^3, so odor MONITORING generally works well as an early warning system.[39, 83-87]

Air Turnover Rates

MONITORING COMBINED CHLORINES in the water or VOC concentrations in the air can be used as an alternative to measuring air quality. The AQUATIC FACILITY design engineer should specify what the alternative measurement limit should be in establishing an alternate ventilation air delivery system.

4.6.3 Indoor / Outdoor Aquatic Facility Electrical Systems and Components

Nothing in this CODE should be construed as providing relief from any applicable requirements of the NEC or other applicable local, state, territorial, federal, and tribal laws.

4.6.3.1 General Guidelines

Wiring

Wiring located near or associated with equipment for bodies of water should be installed in compliance with the NEC or with other applicable local, state, territorial, federal, and tribal laws, except where the MAHC is more restrictive.

- See NEC Article 100: *Location, Wet*.
- See NEC Article 110.11: *Deteriorating Agents*.

Sealed Conduit

Electrical conduit that enters or passes through an INDOOR AQUATIC FACILITY should be sealed at the point of entry into the INDOOR AQUATIC FACILITY against the movement of liquids and vapors through the conduit. Exceptions may include:

- A conduit which only passes through an INDOOR AQUATIC FACILITY, and which has no fittings or joints exposed to INDOOR AQUATIC FACILITY air, should be acceptable without a seal.
- Rigid or intermediate conduit which passes through an INDOOR AQUATIC FACILITY, and which is assembled with threaded couplings only should be acceptable without a seal where at least three threads are engaged at every joint.
- Conduit which passes through an INDOOR AQUATIC FACILITY, and which is assembled with rain-tight compression fittings only should be acceptable without a seal.
- Otherwise-approved non-metallic conduit assembled by glued joints or other solvent-welding method may be acceptable without a seal, where approved by the AHJ.

Note: *An explosion-proof seal is not required, unless required by the AHJ.*

- See CSA C22.2, Canadian Standards Association.
- See NEC Article. 110.11: *Deteriorating Agents*; National Electric CODE.
- See NEMA 250, National Electrical Manufacturers Association.
- See UL 50, Underwriters Laboratories.
- See UL 508, Underwriters Laboratories.

Where such devices must be installed in an INDOOR AQUATIC FACILITY or in spaces containing INDOOR AQUATIC FACILITY air, ENCLOSURES rated NEMA 4X are preferred.

Electric Panels

Electrical panel boards, distribution centers, motor-control centers, fuse panels, circuit-breaker panels, and similar equipment should not be installed in INDOOR AQUATIC FACILITIES or in any space that normally contains INDOOR AQUATIC FACILITY air. Exceptions may include:

- Equipment, which is CERTIFIED, LISTED, AND LABELED for the conditions, should be acceptable where approved by the AHJ.
- Where SAFETY switches or equipment-disconnect switches must be installed in an INDOOR AQUATIC FACILITY or in spaces containing INDOOR AQUATIC FACILITY air, e.g., per NEC, they should be rated for the conditions.
- Whips consisting of liquid-tight flexible metal conduit are preferable to BX cable or type AC conduit.

For More Information:

- See CSA C22.2, Canadian Standards Association.
- See NEC Article. 110.11: *Deteriorating Agents*; National Electrical Code.
- See NEMA 250, National Electrical Manufacturers Association.
- See UL 50, Underwriters Laboratories.

- See UL 508, Underwriters Laboratories.

Exposed Wiring

Where INDOOR AQUATIC FACILITY lights, attachments, fasteners, and any associated wiring whips are exposed to INDOOR AQUATIC FACILITY air, they should be rated for the conditions[88].

- See ANSI/IEEE 241, Section 5.17.6.
- See Soares Book on Grounding, 8th Ed., 2001, p157.
- See NEC Article. 250-110(2).

Metal Raceways

Metal RACEWAYS should be equipped with a grounding conductor sized according to NEC Article 250 to maintain device ground potential in the event of degradation of the RACEWAY.

- See CSA C22.2, Canadian Standards Association.
- See NEC Article 110.11: Deteriorating Agents, National Electrical Code
- See NEMA 250,
- See UL 50, UL 508.

Any electrical switch installed in an INDOOR AQUATIC FACILITY shall be rated for the atmosphere. Exception may include a switch which is otherwise protected, as in a gasketed weather-tight box with a weather-tight actuator cover shall be acceptable[89].

4.6.3.1.2 Indoor Aquatic Facilities

- See NEC Article. 300.7; RACEWAYS Exposed to Different Temperatures, National Electrical Code.
- See Air Leakage Test Protocol for Building Envelopes.
- See Air Leakage Testing and Air Sealing in Existing Multifamily Units.

4.6.3.2 Electrical Equipment in Interior Chemical Storage Spaces

Raceways

All RACEWAYS and RACEWAY devices and boxes in a CHEMICAL STORAGE SPACE should be non-metallic or otherwise rated for the atmosphere[88].

- See NEC Article. 110.11: Deteriorating Agents.
- See NEC Article. 378.10: Non-Metallic Raceways.
- See NFPA 70HB08 NEC Handbook, Art. 100, “Labeled,” Explanatory Note.
- See SDS Calcium Hypochlorite, Section 10 Stability and Reactivity Data.
- See SDS Sodium Hypochlorite, Section 10 Stability and Reactivity Data.
- See SDS Hydrochloric Acid, Section 10 Stability and Reactivity Data.
- See SDS Muriatic Acid, Section 10 Stability and Reactivity Data.

Sealed

RACEWAYS should be sealed at the point of entry to the CHEMICAL STORAGE SPACE to prevent the egress of liquids, fumes, vapors, and gases from the CHEMICAL STORAGE SPACE via the conduit[89].

Note: Explosion-proof seals are not required, unless required by the AHJ.

- See NEC Article. 300.7: *Raceways Exposed to Different Temperatures*.

Metal Raceways

Metal RACEWAYS should be equipped with a grounding conductor sized according to NEC Article 250 to maintain device ground potential in the event of degradation of the RACEWAY[88].

- See ANSI/IEEE 241, Section 5.17.6.
- See *Soares Book on Grounding*, 13th Ed., 2017.
- See NEC Article 250-110(2).

Electronics

All electrical equipment, devices and FIXTURES should be CERTIFIED, LISTED, AND LABELED for the expected atmosphere of the space.

- See NFPA 70HB08 NFPA NEC Handbook, Article 100: *Labeled, Explanatory Note*.
- See NFPA 70HB08 NFPA NEC Handbook, Article 100: *Listed, FPN*.

Light Switches

Any light switches installed inside interior CHEMICAL STORAGE SPACES should be approved for use in wet and CORROSIVE atmospheres, or shall be otherwise protected, as by a weather-proof actuator cover with a gasket.

- See NEC Article 110.11: *Deteriorating Agents*.

Permanent Electrical Devices

All permanently connected electrical devices should be grounded per the NEC or other applicable local, state, territorial, federal, and tribal laws, using a separate grounding conductor which does not depend on the conductive integrity of any metal conduit exposed to CHEMICAL STORAGE SPACE air(88).

- See ANSI/IEEE 241, Section 5.17.6.
- See *Soares Book on Grounding*, 13th Ed., 2017.
- See NEC Article 250-110(2).

4.6.3.2.1 Wet and Corrosive

- See NEC Article 100: *Location, Wet*.
- See NEC Article 110.11: *Deteriorating Agents*.
- See SDS Calcium Hypochlorite, Section 10 Stability and Reactivity Data.
- See SDS Sodium Hypochlorite, Section 10 Stability and Reactivity Data.
- See SDS Hydrochloric Acid, Section 10 Stability and Reactivity Data.
- See SDS Muriatic Acid, Section 10 Stability and Reactivity Data.

4.6.3.2.2 Electrical Conduit

- See NEC Article 110.11: *Deteriorating Agents*.
- See NEC Article 300.7: *Raceways Exposed to Different Temperatures*.
- See SDS Calcium Hypochlorite, Section 10 Stability and Reactivity Data.
- See SDS Sodium Hypochlorite, Section 10 Stability and Reactivity Data.
- See SDS Hydrochloric Acid, Section 10 Stability and Reactivity Data.
- See SDS Muriatic Acid, Section 10 Stability and Reactivity Data.

4.6.3.2.3 Electrical Devices

Electrical panel boards, circuit breakers, disconnects, motors, motor overloads, and similar devices or equipment are included(90).

- See NEC Art. 110.11: *Deteriorating Agents*.

4.6.3.2.4 Protected Against Breakage

- See SDS Calcium Hypochlorite, Section 7 *Handling and Storage*, “Keep away from heat. Keep away from sources of ignition.”
- See SDS Calcium Hypochlorite, Section 10 Stability and Reactivity Data

4.6.4 Pool Water Heating

Evaporation Control

Other CODES do not address the need for constant control of INDOOR AQUATIC FACILITY air temperature to control evaporation. They also do not address the need for heat on specific surfaces. INDOOR AQUATIC FACILITY heating equipment should be selected and installed to preserve compliance with the NEC, the National Fuel Gas Code (ANSI Z223.1/NFPA 54 *if applicable*), the 2018 International Mechanical Code, or other applicable local, state, territorial, federal, and tribal laws, the terms of equipment listing and labeling,

and with the equipment manufacturer's installation instructions. A method of space heating capable of continuously maintaining the temperature of the air in an INDOOR AQUATIC FACILITY at or above the design temperature relative to the POOL water temperature shall be provided. ASHRAE 99.6% climate data are the most reliable for INDOOR AQUATIC FACILITY load calculations.

- See 2017 *ASHRAE Handbook of Fundamentals*(62)

Uncontrolled Condensation

Uncontrolled condensation in a building can lead to the growth of molds, with subsequent health effects, and property damage from rust, rot, ice pressure, and other. Condensation can be controlled by:

- Controlling the evaporation rate of the water,
- Controlling the temperature and relative humidity of the room air, and
- Maintaining all exposed building surfaces above room-air dew point.

Evaporation Rate

The POOL evaporation rate is affected by the:

- Size of the POOL,
- Agitation of the water,
- Heat of vaporization of the water at that temperature and pressure,
- Temperature difference between the POOL water and the room air and the associated difference in vapor pressures, and
- Speed of the air over the POOL's surface.
- See Places of Assembly, 2017 *ASHRAE Handbook of Fundamentals*(62, 91).

Example for Note: A design POOL-water temperature is 82°F *(27.8°C)* with a design air temperature of 84°F *(28.9°C)*. If it is decided to raise the POOL water temperature to 83°F *(28.3°C)*; the air temperature should be raised to 85°F *(29.4°C)* to maintain the same evaporation rate. Any surface which is exposed to room air and which cools below the dew point of the room air will become wet with condensation. Such surface might not be visible, e.g., inside a wall.

Seasonal Disabling

Where POOLS are filled or partially filled, the evaporation rate will increase as room air temperature decreases. Seasonal disabling of space heating could allow a drop of room temperature, with a subsequent increase in evaporation rate and possible uncontrolled condensation.

Surfaces where the temperature might decrease below the design dew point of the space under normal operation shall be identified as part of the design process. At least one inspection should be done during the first heating season to identify any other such surfaces. The addition of heat to surfaces identified might be necessary to maintain their temperature above the design dew point for the space. Where forced air is used to heat identified surfaces, the heating method specified shall be so installed as to heat the room's air supply. The temperature, flow rate, and delivery of the supply air for each identified surface shall be such as to heat that surface above the design dew point of the space, under the worst-case design conditions. Such surfaces might have low values of thermal resistance. Such surfaces might include, but are not limited to windows and their frames, doors and their frames, any metal structural members that penetrate the vapor retarder, and any under-insulated sections of walls or roofs.

- See Thermal and Water Vapor Transmission Data, 2017 ASHRAE Handbook of Fundamentals(91).

Combustion Heaters

Where combustion space heaters or combustion heaters required are located inside a building, the space in which the heater(s) or an assembly including the heater(s) is located shall be considered to be an EQUIPMENT ROOM OR AREA for the purposes of MAHC 4.9.1. The requirements of MAHC 4.9.1 shall apply. Exceptions may be made for space heaters that have been CERTIFIED, LISTED, AND LABELED for installation in the atmosphere without requiring isolation from chemical fumes and vapors.

4.6.4.1 High Temperature

This temperature limit shall not be construed to be the maximum limit of the bulk water (water in the heater) temperature. Bulk-water temperature limits can be much higher. The temperature limit of MAHC 4.6.4.1 is for water in contact with BATHERS. To meet the limits set in 4.6.4.1, water heaters can:

- Heat the water stream to the limit of MAHC 4.6.4.1 and return the water directly to the AQUATIC VENUE, or
- Heat the bulk water above the limit set in MAHC 4.6.4.1 and then use mixing or other methods to ensure that BATHERS are not exposed to temperatures above the limit of MAHC 4.6.4.1.(92)

Examples of "applicable CODES" include but are not limited to:

- IMC 304.1.
- NEC, and
- National Fuel Gas Code *(if applicable)*.

4.6.4.4 Equipment Room Requirements

Combustion heaters should not be installed in an INDOOR AQUATIC FACILITY, or exposed to other chemical fumes, unless the heater is rated for the atmosphere. Many POOL heaters are in CORROSIVE environments that can compromise the heater and venting systems leading to an increased risk of building occupant exposure to harmful products of combustion such as carbon monoxide.

4.6.5 First Aid Area

4.6.5.1 Station Design

A conveniently designated first aid station location should be provided for use when BATHERS report with minor injuries or illness. The first aid station must be easy to locate and must have first aid supplies to care for minor injuries and more serious injuries until emergency assistance can arrive. Some AQUATIC FACILITIES might have a formal First Aid Station that is a stand-alone and others might have a location for first aid equipment. The MAHC allows for flexibility in design to call out the location for first aid equipment rather than designate a stand-alone station. Some AQUATIC FACILITIES are large and a single first aid station is not as practical as distributing first aid equipment throughout the AQUATIC FACILITY *(e.g., to individual AQUATIC VENUES)*. From a design standpoint, the designer must address the location of such equipment and as stated in MAHC 4.5.1, should work with the owner or aquatic risk management consultant to designate these locations.

4.6.6 Emergency Exit

4.6.7 Drinking Fountains

4.6.7.1 Provided

A drinking fountain is required at an AQUATIC FACILITY simply to encourage swimmers to keep hydrated and not to drink the POOL water. At an outdoor AQUATIC FACILITY, the drinking fountain can be located inside an adjacent building to allow year-round use when the AQUATIC FACILITY is closed for the winter. The drinking fountain would not need to be winterized. When a drinking fountain is not located in the AQUATIC FACILITY, it should not be located more than 25 feet *(7.6 m)* from the AQUATIC FACILITY entrance. The AHJ may approve a bottled water supply in place of a drinking fountain. The water from a bottled water supply shall be as readily accessible to BATHERS as would the water from a drinking fountain.

4.6.8 Garbage Receptacles

4.6.9 Food and Drink Concessions

4.6.10 Spectator Areas

4.6.10.3 Balcony

The intent is to prevent people from using a balcony as a diving platform. If a balcony is close to, within 10 feet *(3.0 m)* or overhanging an AQUATIC VENUE, some people might try and use it to jump or dive into the

AQUATIC VENUE. The IBC requires guards that are at least 42 inches *(1.1 m)* high at balconies in commercial facilities. However, the IBC guard is designed to prevent accidental falls and NOT to prevent a person from using the balcony or guard to jump or dive into a POOL. To meet this intent, the guard should be more substantial and preventive. As a supplement to IBC requirements, the guard should be designed like a POOL ENCLOSURE to be at least 48 inches *(1.2 m)* high, to resist climbing, and to not have a ready footing to allow a person to climb on the guard and jump off into a POOL. The intent is to design the guard so that a person is not likely to use the balcony or guard to jump or dive into a POOL.

4.6.10.4 Bleachers

Many building CODE jurisdictions might not be aware of the new ICC 300 bleacher STANDARD. Once jurisdictions adopt the 2017 IBC and supplements, the bleacher STANDARD will become better known.

4.6.11 Indoor Aquatic Facility Acoustics

Guidelines

There are several US and international guidelines recommending limiting BACKGROUND NOISE[93] and suggest values for sound insulation, impact noise, REVERBERATION TIME[93] and equipment noise emissions[94-96]. For example, ANSI/ASA S12.16 recommends STC 60 for school POOLS. In 1974, an EPA report, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety" (https://archive.epa.gov/epa/aboutepa/epa-identifies-noise-levels-affecting-health-and-welfare.html) identified 70 dB over 24 hours (75 dB over 8 hours) as the average exposure limit to environmental noise. Likewise, levels of 55 dB outdoors and 45 dB indoors were identified as the highest average levels of noise that will permit spoken conversation, sleeping, working, and recreation. These are average levels, not peak levels. These limits are not a STANDARD or regulation. They do give local, state, territorial, federal, and tribal governments the basic information they can, and do, use in setting their own STANDARDS. Similarly, the World Health Organization (WHO) report, "Environmental Noise Guidelines for the European Region (2018)" (https://www.euro.who.int/en/health-topics/environment-and-health/noise/publications) recommends that noise exposure levels should not exceed 70 dB over a 24 hour period, and 85 dB over 1 hour period to avoid hearing impairment. Local, state, territorial, federal, and tribal laws usually relate to noise annoyance rather than to hearing hazard risks. In certain situations, such as when recreational exposures are loud because of amplified music or at gaming arcades, local, state, federal, territorial, and tribal laws might require the use of hearing protection devices. For example, the City of San Diego noise ordinance (https://www.sandiegocounty.gov/content/dam/sdc/cob/ordinances/ord9962.doc) does not allow for over 55 dBA one-hour average sound level in multifamily residential facilities during the day; and 65 dBA in commercial facilities. In workplaces, the Occupational Safety and Health Administration (OSHA) requires that average noise exposures not exceed 90 dB for an 8-hour workday. The National Institute for Occupational Safety and Health (NIOSH) and the World Health Organization (WHO) recommend that the highest permissible level of noise exposure in the workplace is an average of 85 dB over an 8-hour day.

Health Effects of Noise

Over time, any sound that is 85 decibels or higher can cause hearing loss or other health problems. The louder a sound is, and the longer you listen to it, the more it can damage your hearing. Hearing loss can also result from a onetime exposure to a very loud sound or blast. The hearing loss progresses if the exposure continues. Early damage might not show up on your hearing test but can create a 'hidden hearing loss' which may make it difficult for you to understand speech in noisy environments. In addition to hearing loss, exposure to noise can cause other health problems: Increased stress, anxiety, and fatigue; elevated blood pressure, cardiovascular disease, loss of sleep, and increased heart rate; ringing, hissing, or roaring in the ears (tinnitus) usually occurs immediately, but then it usually, but not always, goes away. It can, however, be an indication of early hearing damage. Sounds which would otherwise seem normal to most people, might start to sound unbearably loud (hyperacusis). People suffering from this increased sensitivity to sound might experience discomfort or physical pain. Lifeguards need to be especially attentive and vigilant to detect early signs of drowning. However, noise has been found to decrease cognitive task performance and vigilance, as well as music itself being distracting to performance of certain tasks[97]. Noise during lifeguard scanning constitutes

a potential distracting factor for lifeguards as it can hinder attention to signals from peripheral vision[98]. Noise-induced hearing loss is permanent; thus prevention is vital. You can use a sound level meter to measure sound around you, including using free sound level meters developed as "apps" for smartphones. Even without a device to measure sound, you can tell if sound is too loud. If you or others need to shout to be heard or cannot understand each other even at arm's length away, the sound is too loud. The three general steps you can take to protect your hearing are turning the noise down, walking away, and using hearing protection. Hearing protection devices are worn to reduce the level of sound entering the ear. Hearing protection that is improperly fitted or not worn at the time of exposure will not protect hearing. Hearing protection devices come with different noise reduction ratings (NRRs). Most hearing protection devices have NRRs that range from 0 dB to 35 dB. NRR is a "best-case" rating measured in a laboratory. The actual sound reduction is less than the number listed for the device when worn correctly. As a basic guide, subtract 7 from the NRR number, then divide the result by 2 to see how well the device might reduce your exposure. For example, you might wear earplugs with an NRR of 27 dB to a concert where the sound reaches 100 dB. You calculate the actual noise reduction as (27 – 7)/2 = 10. Your earplugs reduce the sound by 10 dB, so your exposure (100 dB – 10 dB) is 90 dB. For more information refer to The Occupational Safety and Health Administration Methods for Estimating the Adequacy of Hearing Protecter Attenuation 29 CFR 1910.95 App B (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9737).

The most common types of hearing protection devices include the following:

1) Insert type earplugs: These devices provide an airtight seal with the ear canal, and are cheap, effective, and easy to use. They can be pre-molded (pliable devices of fixed proportions), formable (usually made of expandable foam), custom-molded (to fit precisely the size and shape of an individual's ear canal), and canal caps (earplugs on a flexible plastic or metal band).
2) Earmuffs come in many models designed to fit most people. They block out noise by completely covering the outer ear. Some earmuffs also include electronic parts to help users communicate or to block sound impulses or BACKGROUND NOISE.

Noise Levels in Indoor Aquatic Facilities

People in INDOOR AQUATIC FACILITIES can be exposed to various noise sources such as music, HVAC systems, pumps, and other noise sources. There are only few studies measuring sound levels in POOLS. For example, studies have reported high REVERBERATION TIME inside school swimming POOLS (recommended lower than 2.0 sec; measured above 4 seconds). Those studies also reported that although teachers in school swimming POOLS had weekly noise exposures below 80 dBA, the Lpeak sound levels reached 120 to 124 dBA[99]. Music levels in indoor parties and nightclubs have been measured at 95–115 dB. Some hearing loss can occur at 100 dBA after 15 minutes, and after just a few minutes at 120 dBA. Consideration was given to adding a requirement for provision of a noise MONITOR with local visual alarming in the natatorium that would be triggered if noise levels above a specific decibel level were exceeded, to alert PATRONS and QUALIFIED OPERATOR, RESPONSIBLE SUPERVISOR, or staff. The intent of this requirement would be to alert staff of excessive noise levels and limit noise exposure, especially given the negative effects of noise on lifeguard vigilance and communication. The alarm would need to be a visual alarm, such as a strobe, as an audible alarm might not be heard and would add to the excessive noise level, and signage to notify facility management would need to be present adjacent to the visual alarm. A corresponding operational requirement would be that the noise MONITOR with visual alarm be maintained in working condition. The use of such an alarm was determined not to be feasible at this time due to the following factors which need further research and discussion. These issues should be addressed to allow for future consideration of this option:

- Can cost be justified? The cost of a sound meter coupled with an alarm is substantial; OSHA Standards (29 CFR 1910.95 Appendix G) state that sound level meters cost about $500 to $1,000[100].
- Is there justification to require for all facilities? OSHA Standards (29 CFR 1910.95 (d)) only require MONITORING when information indicates an employee's exposure might equal or exceed an 8-hour time-weighted average of 85 decibels or a dose of 50[101]. No precedent in building CODE or other STANDARDS was found that requires preemptive use of sound alarms.

- What would be the expected and appropriate follow-up actions if the alarm is triggered? Would single or repeated exceedances require action on the part of the facility? Should any operational steps be taken immediately? Could capacity be reduced? Is retrofitting a viable option? Should next steps include requiring the facility to consult with a professional, industrial hygienist, or noise control engineer to develop a solution? What would be the cost of this, and of implementing engineering and administrative controls? How would PATRONS be informed of the purpose of the alarm, what it indicates, and what to do if it were to go off? Use of sound absorbing materials can reduce the noise created from sound reflection off of facility surfaces (walls, roof, etc.) but it cannot reduce "direct noise." For example, the noise created by PATRONS in an outdoor POOL could reach 70-85 dB; and sound reflection of the same POOL in a natatorium might be 10-15 dB higher. But acoustic design and use of sound absorbing materials would only eliminate the 10-15 dB, it would not be able to reduce the noise generated by PATRONS, etc. during use of the facility, so there might be limited options to reduce noise levels if a prescribed noise level were to be exceeded.
- What would the alarm setpoint be? If the AQUATIC FACILITY had lifeguards or other staff present, the alarm setpoint would need to be at least as conservative as the OSHA permissible exposure limit or NIOSH recommended exposure limit (NIOSH being more protective). If other guidelines are used, such as EPA's 1974 recommendations or those in the WHO Guidelines for Community Noise (https://apps.who.int/iris/handle/10665/66217), NIOSH provides a discussion regarding noise exposure limits for occupational rather than general environmental noise (https://blogs.cdc.gov/niosh-science-blog/2016/02/08/noise/). Should the setpoint be for exceedance of an average noise level over a specific duration (a time-weighted average), or for exceedance of a designated level at any time?

Background on Acoustical Issues

It has been documented in the acoustic literature that high levels of noise adversely impact people's health and wellbeing. It has been shown "that chronic noise exposure increases stress and reduces the quality of life for those exposed"(102). It has also been shown that "noise can tire out the inner ear, causing temporary hearing loss"(103). "In several tests, it has been established that productivity and efficiency can be seriously affected by high noise levels and that fewer mistakes are made when noise levels are reduced"(104). Alongside these issues, noise can also present issues to the SAFETY and wellbeing of staff and PATRONS. It is imperative that emergency broadcast signals played through a public address system be clearly audible above the background sound. It is therefore necessary to provide an environment that controls excessive noise and REVERBERATION(93) and allows the public address system to maintain clarity and intelligibility. Many industries have recognized the health effects that noise has on its workers and other stakeholders and have developed STANDARDS and regulations to deal with noise using absorbing materials, improving sound transmission between spaces, and limiting building equipment noise. These include STANDARDS for classrooms, offices, healthcare facilities, and limiting of occupational noise exposure through OSHA. Limiting excessive REVERBERATION and loudness through use of absorbing materials to treat the room helps:

1) "Reduce noise affecting staff below statutory, advised, or desired limits.
2) To improve communication, (i.e., to allow direct speech communication between staff [e.g., for instructions or warning of imminent danger]), and to improve attention to public address system, telephone, fire warning bells, or other electroacoustic systems.
3) To reduce the sound pressure level incident on the building envelope, thereby reducing the required sound insulation performance of the ENCLOSURE when considering noise breakout. Conversely, in cases where noise breaks in, treatment limits the amplification of the noise by the space itself."(104)

Sound System/Public Address System

For INDOOR AQUATIC FACILITIES with a sound system or audio/visual system that plays amplified sounds, it is recommended that the sound system be designed so that the loudspeaker coverage with optimize speech intelligibility (STI) to 0.5 to 0.6 or higher and use strategically placed absorbent material in spaces that will optimize speech intelligibility. One major issue in AQUATIC FACILITIES with a public-address system is ensuring that the public address system can be heard clearly, especially when an emergency occurs. The Speech Transmission Index (STI) metric predicts the intelligibility of speech transmitted from talker to listener by a transmission channel(105). The STI is a numerical rating system between 0 and 1 representing

the transmission quality of speech. An STI rating of 0.5 is considered a "target value for public address systems" and an STI value of 0.6 is considered to be between "*High quality* public address systems" and "*Good Speech Intelligibility"* according to the BS EN 60268-16:2011.

Sound Blocking/Transmission

It is recommended that single or composite wall and floor-ceiling assemblies separating INDOOR AQUATIC FACILITIES and adjacent spaces be designed, constructed, and installed to conform to the following minimum STC(95) Ratings. Note that this CODE addresses acoustics in the part of the AQUATIC FACILITY where the water "vessel" is located (natatorium) and not at other areas of buildings (which would be covered by the building CODE). Therefore, since these design recommendations address walls/ceilings/floors between an INDOOR AQUATIC FACILITY and other rooms in a building, they are presented as recommendations in the Annex.

Table 4.6.11: Recommended Minimum STC Ratings for Indoor Aquatic Facilities

Source Space	Receiving Space	Indoor Aquatic Facility STC Rating
Indoor Aquatic Facility	Hygiene Facility or Corridor	45
Indoor Aquatic Facility	Corridor used as ancillary learning space or with lodging/sleeping rooms	55
Indoor Aquatic Facility	Aquatic director's office or guard/admin room with/without viewing window	60 without window; composite STC rating of 35 for wall with window
Indoor Aquatic Facility	All other noise sensitive spaces not listed above, including offices, classrooms, conference rooms, and lodging/ sleeping rooms	60
Equipment Room / Mechanical Room	Indoor aquatic facility: all noise sensitive spaces including those listed above	60

*If amplified music, amplified public address announcements, competitions, large crowds of people cheering or other loud sounds are anticipated in the aquatic area, increased STC ratings might be necessary. Analysis should be performed to determine the necessary STC rating of the partition based on typical anticipated sound levels while occupied.

Limiting sound bleed between the INDOOR AQUATIC FACILITY and adjacent spaces is necessary to provide a comfortable acoustic environment. The STC rating of the separating assembly should be selected based on the anticipated level of sound in the natatorium and the maximum desirable level of background sound in the adjoining space. ANSI/ASA S12.60 recommends a minimum STC rating of 55 between an indoor swimming POOL and a corridor used as an ancillary learning space, a minimum STC rating of 60 between an indoor swimming POOL and a music room, and a minimum STC rating of 60 between an indoor swimming POOL and an office or conference room(95). LEED Version 4 requires a minimum composite STC rating of 60 between mechanical EQUIPMENT ROOMS OR AREAS and occupied areas(106).

4.6.11.1 Acoustic Design Criteria

4.6.11.2 Sound Absorption

INDOOR AQUATIC FACILITIES designed to meet a minimum AVERAGE SOUND ABSORPTION COEFFICIENT (ALPHA BAR ($\bar{\alpha}$))(93, 107) of 0.20 would be a space that begins to absorb sound, instead of amplifying it. It is recommended that the INDOOR AQUATIC FACILITY be designed with an ALPHA BAR of 0.25, which provides a reasonable degree of acoustic comfort. It is preferable that an INDOOR AQUATIC FACILITY be designed with an ALPHA BAR of 0.30 to 0.40, which provides the most acoustic comfort and speech clarity.

4.6.11.2.1 Facilities Used Primarily by Specific Hearing Populations

For INDOOR AQUATIC FACILITIES whose main clientele will be young children, the elderly, or any persons with hearing difficulties, a higher ALPHA BAR is necessary. For these facilities, an ALPHA BAR of 0.30 is recommended, and an ALPHA BAR of 0.35 to 0.45 is preferred.

Specific Hearing Populations

It has been documented in the acoustic literature that persons with hearing impairment require higher signal to noise ratios to hear spoken words with clarity and intelligibility than persons of normal hearing sensitivities(108). Children do not typically hear as they would as an adult until they reach age 13–15 years(108). The elderly population typically have diminished hearing abilities in the higher frequencies as they age, a condition known as presbycusis, even if they have not had any noise-induced hearing loss or illness resulting in hearing loss(109). It can therefore be concluded that higher signal to noise ratios is needed when young persons and elderly persons use a facility. BACKGROUND NOISE in AQUATIC FACILITIES comes from three main sources: 1. Sound people make – talking, splashing, etc. 2. Sound reflections and REVERBERATION, and 3. Building equipment. All three need to be controlled to improve the signal to noise ratio. This can be achieved through the building design by using adequate finish materials and by lowering the NOISE CRITERION to effectively make the building equipment noise quieter.

4.6.11.3 Noise

Sounds from AIR HANDLING SYSTEM equipment should not be higher than a maximum NOISE CRITERION(110) level of 50 because limiting the BACKGROUND NOISE associated with mechanical units aids in reducing overall sound levels in the facility and assists in maintaining clarity and intelligibility of the spoken word. It is recommended that an INDOOR AQUATIC FACILITY be designed to meet a NOISE CRITERION of 45, which provides a reasonable sound level. It is preferable that an INDOOR AQUATIC FACILITY be designed with a NOISE CRITERION level of 40 which provides an acoustic environment that will help facilitate communication. The ASHRAE Handbook on HVAC Applications recommends limiting the NOISE CRITERION level to 45 in natatoriums(110). Noise control and vibration isolation for AQUATIC VENUE equipment, pumps, heaters, filters and other POOL equipment and piping might be necessary to meet the NOISE CRITERION level for the space.

4.6.11.4 Sound Absorbing Materials

Special attention should be given to the selection of sound absorbing finishes, especially those that could come in direct contact with water and chemicals, such as CHLORINE. The material also shall be able to withstand exposure to humidity. Any acoustical products selected should be verified as intended for use in INDOOR AQUATIC FACILITY environments.

4.6.11.5 Concave Room Surfaces

Concave wall and ceiling surfaces typically result in sound focusing or creep, which are acoustical defects. Surfaces such as domes, circles, ellipses, and parabolas cause sound reflections to converge at a focal point thereby producing sound focusing(109). The curving of a dome on a roof or similar roof structure tends to reflect sounds that are propagated in the space back into the space at certain points, with many reflections overlaying on each other. This phenomenon creates excessive loudness and sound buildup in these focal points. Another acoustic issue known as creep might occur with a concave space, whereby sound is reflected many times across the surface of the curved surface and reflected across the room. These acoustic phenomena contribute to overall increases in loudness and REVERBERATION and results in unintelligible speech. To avoid these phenomena, it is necessary to treat any concave type wall and ceiling areas with sound absorbing material or to consider changing the geometry of the surface or adding elements that can scatter or diffuse the sounds(109).

4.7 Recirculation and Water Treatment

4.7.1 Recirculation Systems and Equipment

4.7.1.1 General

Rationale for Prescriptive Approach

MAHC recirculation and water treatment systems guidance tends to be more prescriptive than performance based because it is difficult and expensive to measure the performance of the filtration and RECIRCULATION SYSTEM with regard to pathogen removal or inactivation. Even the measurement of water clarity (e.g., turbidity) can be difficult (due to potential bubble formation, instrument fouling, and instrument calibration procedures) and can cost more than a thousand dollars to continuously measure turbidity at a single point.

Reasons to Exceed the Minimum Standards

There is no single TURNOVER TIME or one type of filtration system that is optimal for every AQUATIC VENUE. Requiring the most aggressive design for every AQUATIC VENUE is not the intent of the MAHC (or even necessary). However, some AQUATIC VENUES, particularly those with high numbers of BATHERS per unit water volume or a BATHER population more likely to contaminate water (e.g., children less than 5 years of age), could need higher recirculation rates and more efficient filtration than the minimum STANDARDS. Since it is not always possible to predict the number of BATHERS in an AQUATIC VENUE, the MAHC recommends a modest overdesign of the RECIRCULATION SYSTEM pipes and thus ample space be left for expansion of pumping and filtration capacities, which will be referred to henceforth as the hydraulic flexibility recommendation. Future editions of the MAHC could have higher minimum STANDARDS that AQUATIC FACILITIES might wish to comply with without having to remove and replace a lot of concrete to accommodate slightly larger pipes.

Hydraulic Flexibility Recommendation

The hydraulic flexibility recommendation made in the section above will also reduce friction losses in the pipes that might lead to energy savings and reduced operating costs. With the formalization of a new turndown system for AQUATIC VENUES, it is hoped that AQUATIC VENUES might be designed for worst-case conditions and then operated according to the demands placed on the system. A turndown system could be used to operate below the minimum operational STANDARDS set by the MAHC when the AQUATIC VENUES is not occupied as an additional cost-saving measure as long as water quality criteria are maintained.

4.7.1.2 Combined Aquatic Venue Treatment

The following considerations are important to the treatment of combined AQUATIC VENUES, and this practice is generally discouraged for most installations. First, to respond to a contamination event, it would be necessary to shut down all AQUATIC VENUES and water features on a combined AQUATIC VENUE treatment system since contamination of one AQUATIC VENUE would rapidly contaminate all combined AQUATIC VENUES. Second, including an INCREASED RISK AQUATIC VENUE on a combined system would require SECONDARY TREATMENT to be installed for all AQUATIC VENUES on the RECIRCULATION SYSTEM. The two scenarios would involve isolating *Cryptosporidium* to a single AQUATIC VENUE (limiting the number of BATHERS exposed while keeping the concentration high) or diluting it as much as possible between all AQUATIC VENUES (to limit the maximum concentration or exposure level while increasing the number exposed). Based on the infectious dose concept (i.e., the number of OOCYSTS required to be ingested to cause an infection), diluting *Cryptosporidium* or other CONTAMINANTS is one way of reducing outbreak potential but the high numbers of *Cryptosporidium* OOCYSTS that can be excreted (e.g., 10^8–10^9 per contamination event[111, 112]) might overwhelm modest dilution factors while greatly increasing the number of people exposed. While the number of BATHERS exposed might increase, the exposure level will decrease if circulation rates were the same, meaning dilution of a very small AQUATIC VENUE into a large POOL might reduce the *Cryptosporidium* level from 1000's of OOCYSTS per mL swallowed to less than 1 per mL in the combined system. However, smaller AQUATIC VENUES can be circulated at faster rates through the SECONDARY TREATMENT and therefore can have OOCYSTS loads reduced faster if they are in a small volume, rapidly circulating AQUATIC VENUE. Design modeling is needed to compare the efficacy of these two scenarios under different OOCYST concentrations. The dilution scenario only works if an INCREASED RISK AQUATIC VENUE of small volume is combined with a large volume AQUATIC VENUE. For AQUATIC VENUES similar in size, the impact of dilution is small while the number of people exposed might double or more. There could also be benefits with a combined system that would make it easier to provide more stable water quality parameters (in terms of pH and CHLORINE concentration) because larger water volumes tend to be easier to control. Again, the potential positive impact of combined water treatment is limited to combining small POOLS with much larger POOLS, which is not likely if the DISINFECTION requirements differ between

the AQUATIC VENUES. Hydraulically isolating a given AQUATIC VENUE on a combined treatment system with valves is discouraged because doing so necessarily prevents filtration and recirculation of the water. However, isolation capabilities are recommended for maintenance purposes (as well as separate drain piping).

4.7.1.3 Inlets

4.7.1.3.1 General

Flow Velocity

The velocity of flow through any INLET orifice (at 100–150% of the total recirculation flow rate chosen by the designer) should normally be in the range of 7–20 ft/s *(2.1–6.1 m/s)*. The range of velocities through the INLETS was selected to balance two competing goals. (1) The velocity should be high enough to push water effectively to the center of the POOL (or to within the range of the floor INLETS for wider POOLS), but (2) the velocity should not be so high as to waste an unnecessary amount of energy. The INLETS still being within design range at 150% of the design recirculation flow rate is to accommodate the hydraulic flexibility recommendation discussed previously. This recommendation ensures proper operation at both the current and any future flow rates up to at least 150% of the recirculation flow.

4.7.1.3.1.1.1 Alternative Design Justification

Computational Fluid Dynamics (CFD) is an additional design justification option addressing in-POOL circulation to be used to document surface-water circulation performance. This allows the same engineering justification tools to be used for surface-water circulation in POOLS that do not or cannot follow the common design associated with traditional, municipal-type POOLS. This design option is particularly helpful for POOLS that are freeform in shape, POOLS that often include ISLANDS, deep covers, and checkerboard type offsets, and POOL geometry where surface circulation patterns are very difficult to predict in advance. Also see 4.7.1.4.1.1.2 in the CODE.

4.7.1.3.2 Floor Inlets

Maintain and Measure

The use of floor INLETS might require additional considerations for draining them when the POOL is not in use. The likelihood of biofilm proliferation in pipes not in use is thought to increase substantially as the FREE CHLORINE RESIDUAL is dissipated. Drinking water distribution pipes are normally coated with biofilm even in the presence of a constant CHLORINE residual[113, 114]. Since it is more difficult to inactivate microorganisms in a biofilm[114], there is potentially increased risk of human exposure to pathogens shielded by biofilm once the POOL reopens. Leoni and coworkers found mycobacteria in 88.2% of POOL water samples analyzed and reported that swimming POOLS provided a suitable habitat for the survival and reproduction of mycobacteria[115]. Substantial damage to the RECIRCULATION SYSTEM pipes and surroundings can result from the expansion of water as it freezes. Both dangers may be alleviated by simply draining water from the pipes when the POOL is not in use. Provisions might also be recommended to prevent the pipes from refilling with water once drained. Floor INLETS are thought to distribute chlorinated filtered water more effectively to the center of the POOL, thereby reducing the magnitude or likelihood of dead zones in the center of the POOL. For this reason, MAHC 4.7.1.3.1.3.1 requires floor INLETS are required for POOLS greater than 50 feet *(15.2 m)* in width. The designer should consider climate when designing the INLET system and provide proper drainage instructions.

4.7.1.3.3 Wall Inlets

4.7.1.3.3.1 Effective Mixing

For STANDARD POOLS, since much of the water leaving the POOL does so at the surface, locating the INLETS 24 inches *(61.0 cm)* below the design operating water level would reduce short-circuiting of water from the INLETS to the surface removal system.

4.7.1.3.3.3 Inlet Spacing

Wall INLETS have a limited range for how far they can push water out toward the center of the POOL especially as the flow of water is being pulled out of the POOL at the wall via gutters or SKIMMERS. The likelihood of forming regions in the center of the POOL that are not efficiently filtered or chlorinated increases

as the width of the POOL increases. For POOLS less than 4 feet *(1.2 m)* in depth, the average velocity of the water is thought to be increased as the volume of water served by a single INLET is expected to decrease assuming equal spacing. Step areas, swim outs, and similar recessed or isolated areas are likely to create a dead zone. Placement of one or more INLETS in these areas will help ensure distribution of chlorinated, filtered water to these areas.

4.7.1.3.3.5 Dye Testing

Dye testing should be performed to determine and adjust the performance of the RECIRCULATION SYSTEM. Dye studies tend to be qualitative in nature. A dye test may not be necessary for "STANDARD" designs previously determined to provide effective mixing. It might be particularly important for irregular shaped POOLS. Some judgment is generally required to determine whether a dye study should be classified as passing or a failing. In general, dead zones (or areas of poor circulation) would indicate a failure that could be fixed by adjusting the INLETS or other system hydraulics. If the POOL does not reach a uniform color within 15-20 minutes, then adjustments are required. Refer to Appendix 3: Dye Testing Procedure for additional information.

4.7.1.4 Perimeter Overflow Systems/Gutters

4.7.1.4.1 General

4.7.1.4.1.1 Skimming

Perimeter overflow/gutter systems are intended to remove surface water from the AQUATIC VENUE for treatment and recirculation. The intent of a perimeter overflow system is to remove water from all parts of the POOL equally and preclude "dead spots" from occurring. They need to remove water from all parts of the POOL equally. Much of the dirt, oil, bacteria, floating debris, and possibly undissolved chemicals are in the top inch of water. There might also be less DISINFECTANT due to aerosolization and oxidant demand. Indoors, there is some evidence that DBPs build up in the top layer where they are more likely to aerosolize and contribute to poor air quality and BATHER discomfort. Areas that do not have good circulation due to lack of gutters or return grates *(e.g., zero-depth entries)* or which have gutters that are not level might not have adequate flow in these areas and might develop "dead spots" where the DISINFECTANT is not present at adequate concentrations to prevent recreational waterborne illnesses or algae growth. The corners of POOLS with SKIMMERS are a case in point. Unsightly debris such as "oil slicks," blowing paper, dead bugs, and leaves might also collect in these "dead zones."

Designs

Novel designs *(e.g., gutters located on only the two longest sides of the POOLS)* should be subject to approval by the AHJ with proper engineering justification *(e.g., a CFD model of the POOL design demonstrating acceptable hydraulic balance and mixing)*.

4.7.1.4.1.1.2 Novel Perimeter Overflow Systems

A common way of determining in-POOL circulation is constructing a CFD model of the POOL design that documents in-POOL circulation without any surface-water dead zones.

4.7.1.4.2 Perimeter Overflow System Size and Shape

A value of 125% of the total recirculation flow rate chosen by the designer is recommended for hydraulic flexibility.

Oversizing the SKIMMER capacity for point surge. As PATRONS swim, play, dive, and splash, they create waves that exceed the normal recirculation one might see when the POOL is empty. Upsizing the gutter system allows capture of the waves without flooding the gutter, which would make the gutter ineffective. Human body density is approximately equal to water *(fat is less and muscle is more)* at approximately 1 g/mL.

A 200-pound *(91 kg)* person displaces approximately 24 gallons *(90.8 L)*. *(200 lbs. x 0.454 kg/lb. x 1L/kg x 0.264 gal/L = 24 gallons)* The average PATRON is not 200 pounds, so this conservative parameter provides extra capacity in the surge system for more dynamic wave instances.

Surge capacities recommended by state health departments of 1 gallon per square foot *(40.7 L/m²)* of POOL water are common. For an average of 24 *(typically 16–30)* square feet *(2.2 m²; typically 1.5–2.8 m²)* of water per person and 24 *(90.8 L)* gallons per person to be conservative, the net surge capacity is 1 gallon per square foot *(40.7 L/m²)* of POOL. This is not new information and was considered over a decade ago. The State of Iowa tried 2 gal/ft² *(81.5 L/m²)* for a few years but found that to be unnecessary. It continues to work well in POOL designs. Once again, the oversized gutter system is recommended to account for how PATRONS enter and displace the POOL water adjacent to the gutter. The 125% gutter capacity and the 1 gallon of surge per square foot of area both continue to work well in practice. The gutter capacity must be even greater for designs relying on AQUATIC FEATURES and SLIDE flow being returned through the gutter.

4.7.1.4.3 Gutter Outlets

A value of 125% of the total recirculation flow rate chosen by the designer is recommended for hydraulic flexibility. The design goal is to avoid inadequate outlet spacing in these old gutter channels. The spacing between drain outlets should not exceed 10 feet *(3.0 m)* for 2-inch *(5.1 cm)* diameter drains or 15 feet *(4.6 m)* for 2½ inch *(6.4 cm)* drains, unless hydraulically justified by the design engineer.

4.7.1.4.4 Surge Tank Capacity

4.7.1.4.4.1 Net Surge Capacity

The net capacity shall be measured from the minimum operating depth required to maintain pump suction to the bottom of the overflow waste outlet.

Draining

Surge tanks should be provided with means for complete draining to allow routine inspections, maintenance, and cleaning. Proper maintenance will reduce the chances of biofilm formation and bio-corrosion. Surge tanks should also have a means of draining for winterization, where applicable. An overflow is recommended to prevent a POOL from flooding DECK areas *(indoor)* if over filled and flooding filter rooms during rainfall events. An air break is recommended to prevent a CROSS-CONNECTION with the POOL water that could introduce CONTAMINANTS into the POOL.

Contain

Surge tanks can contain valves, piping, float controls, heating system manifolds or heat exchangers, makeup water controls and large basket screens for large AQUATIC FACILITIES. They also can act as a settling basin for large particles and debris coming directly from the main drains and gutters. It is reasonable to drain these tanks to access equipment and remove settled materials.

4.7.1.4.5 Tolerances

Gutter tolerances were chosen to keep water flowing in even proportions from all sections of the POOL and to avoid dead spots and scum lines. Tighter tolerances might be needed for competitive POOLS.

4.7.1.4.6 Makeup Water System

Other BACKFLOW prevention devices may include the following:

- Reduced Pressure Principle assembly,
- Pressure Vacuum Breaker assembly,
- Spill-resistant Vacuum Breaker assembly, or an
- Atmospheric Vacuum Breaker assembly.

All devices may not be appropriate for all installation conditions.

4.7.1.5 Skimmers and Alternative Gutter Technologies Using In-Pool Surge Capacity

4.7.1.5.1 General

4.7.1.5.1.2 Provided

The use of SKIMMERS could be limited to POOLS with surface areas of less than 1,600 square ft *(149 m²)*, and the maximum width for POOLS using SKIMMERS could be restricted to less than 30 feet *(9.1 m)*. The use of

SKIMMERS has been limited to smaller POOLS with light BATHER COUNTS since their inception. The limitations of SKIMMERS versus gutters appear to be physical in nature. For example, a 30 feet x 50 feet *(9.1 m x 15.2 m)* POOL might be served by three SKIMMERS rated at 500 square feet *(46.4 m^2)* each. If each SKIMMER is 1 foot *(30.5 cm)* wide, then all the skimmed water is being drawn off from only 3 foot *(0.9 m)* of the POOL perimeter *(i.e., 1.9 % of the total perimeter)*. This would lead to higher water velocities over the floating weirs and water being collected from a greater depth *(as opposed to actual surface skimming)* relative to a gutter system that extends around the perimeter of the POOL. In this example, 98.1% of the perimeter of the POOL is not being used to skim water and could produce regions of limited flow and scum collection. Theoretically, enough SKIMMERS might be added to produce effective skimming comparable to a gutter system, but the research to demonstrate this in practice could not be found. Practical experience says that having no scum lines or dead zones in corners with stagnant debris are inherent advantages. There could also be practical hydraulic limitations for heavily BATHER loaded POOLS related to use of in-POOL surge as opposed to a surge tank. Equalizer lines are recommended to prevent SKIMMERS from pulling air into the pump and potentially causing loss of prime, flow surges, and interference with proper filter operation.

4.7.1.5.1.3 Hybrid Systems

Hybrid systems that incorporate surge weirs in the overflow gutters to provide for in-POOL surge shall meet all requirements specified for overflow gutters Since the number of BATHERS determines the type of surface overflow system in use, the hybrid systems should be able to meet all CODE requirements regardless of how many BATHERS are present and which components are in active use. When the POOL is inactive (no BATHERS in the water) the surge weirs provide surface skimming. The operating water level during the period when there are no BATHERS in the water is designed to be below the rim of the gutter and flows over the surge weirs by gravity. When BATHERS enter the water, the level rises (in-POOL surge capacity), the surge weir openings close, and the water flows over the gutter as in STANDARD gutters.

4.7.1.5.1.3.1 Surge Weir

The manufacturers of these gutter systems typically have flow capacities (GPM/surge weir) established for their surge weirs. The number of surge weirs necessary to accommodate the portion of the recirculation rate to be removed from the surface is calculated by using the percentage of the total recirculation rate for surface skimming (i.e., 80 % of total flow) divided by the flow rate for each surge weir. The total recirculation rate must not be used for this calculation, as it will result in a greater number of surge weirs; operationally less water will need to be removed from the surface, which will likely result in inadequate flows over the weirs for effective surface skimming. The required number of surge weirs are to be uniformly spaced around the POOL perimeter in the gutter.

4.7.1.5.1.4 Design Capacity

The 100% of the total recirculation flow rate chosen by the designer is recommended as part of the hydraulic flexibility recommendation.

4.7.1.5.3 Skimmer Flow Rate

SKIMMERS should provide for a flow-through rate of 30 GPM *(114 L/min)*, or 3.75 GPM *(14 L/min)* per linear inch *(2.5 cm)* of weir, whichever is greater. The AHJ may approve alternate flow-through rates so long as the SKIMMERS are NSF or equivalent CERTIFIED, LISTED, AND LABELED, and manufacturer's design specifications are not exceeded.

Flotation Test Procedure

Materials Needed:

- Yellow wooden stars *(55–110 minimum depending on the POOL's surface area)*
- Video camera
- Tripod

Conditions Prior to Test:

- TURNOVER TIME and recirculation flow rate are operated as normal for the POOL
- INLETS and outlets are positioned as normal for the POOL

- SKIMMERS or gutter system is not flooded
- If using SKIMMERS, make sure that the weirs are present
- Water level is at the appropriate height above the weir/gutter *(about ¼ inch [6.4 mm])*
- Set up video camera to record

Test 1: Circulation

1. Determine how many stars are necessary by using the following:
   - POOL surface area < 2,500 square feet *(232 m^2)*, use a minimum of 55 stars
   - POOL surface area > 2,500 square feet *(232 m^2)*. use a minimum of 110 stars
2. Randomly toss the stars into the POOL. Try to toss the stars so that there is an even distribution throughout the surface of the POOL.
3. Record and observe the stars as they travel.
4. Record the motion of the stars in each area of the POOL *(e.g., clockwise, counterclockwise, no movement)* and any other observations.
5. Passing criteria might vary, but suggestions include 90% removal within 1 hour.

Test 2: Skimmer/Gutter Draw

1. Stand behind one of the SKIMMERS or the gutter and drop a star into the water at arm's length distance *(about 2 feet [61 cm])* in front of it.
2. Record how long it takes for the star to enter the SKIMMER or gutter. Then repeat this process at the same location three times.

4.7.1.5.3 Prohibited

SKIMMER equalizers are components found in some installations that include a diverter device to allow side-wall suction in the event the water level drops below the mouth of the SKIMMER. If not properly fitted with a compliant SOFA, the equalizer line may present a suction entrapment risk. VGB Act compliant SOFAS are available for existing installations, but new construction or SUBSTANTIAL ALTERATIONS should eliminate SKIMMER equalizers.

4.7.1.6 Submerged Suction Outlet

Note that in the VGB Act, no specific distances are listed.

Safety Vacuum Release System

SAFETY VACUUM RELEASE SYSTEM (SVRS) devices are one of several methods to prevent swimmer entrapment on submerged suction fittings. SVRS devices have been on the market since the 1990s and continue to be installed on swimming POOLS because of their value as a SAFETY feature. In addition to CERTIFIED, LISTED, AND LABELED drain covers, the VGB Act required the installation of an SVRS device for POOLS with a single main drain. The MAHC does not address SVRS devices in Section 4 since the MAHC requires two main drains in 4.7.1.6.2.1), so there should not be a need for a requirement addressing SVRS devices in section 4. ANSI/APSP/ICC-7 has information about SVRS systems and indicates "when used..." and has a caution for incompatible configurations, which lists two or more suction outlets as a potential incompatible configuration. SVRS devices are considered as a secondary line of defense against drain suction entrapment. This means that an SVRS should be used in conjunction with other suction entrapment preventions methods such as two suction fittings at least 3 feet apart, or single "unblockable" suction fittings.

Currently, there are two general types of SVRS devices; mechanical and electrical.

- Mechanical SVRS devices consist of a separate mechanism installed on the piping on the suction side of the filtration system pump or other pump—i.e., the device is located on the suction piping between submerged suction drain fittings and the pump suction. The device is designed to detect an increase in vacuum in the suction piping near the suction fittings—i.e., detect a suction fitting blockage. When a vacuum is sensed above a set threshold, the device is designed to quickly open to the atmosphere, bringing air into the suction piping, thus causing the vacuum to be broken and the suction fitting blockage released.

- Electrical SVRS devices have a similar function. An electrical sensing device is located as an attachment to the pump control system or is integral with the filtration pump or motor itself. When additional vacuum is sensed over a set threshold, instead of a mechanical device opening to the atmosphere, the electrical SVRS device quickly shuts off the pump motor.

Although there are these two general SVRS types, there are some hybrids and variations from the two types.

- Some SVRS devices might or might not shut off the pump.
- Some SVRS devices might or might not open the suction piping to the atmosphere.

There are some potential problems with SVRS devices.

- Since SVRS devices detect vacuum changes, they might unintentionally be triggered by other system vacuum changes such as during the vacuuming of a POOL.
- Any control valves or check valves installed on the pump suction piping can greatly affect or completely defeat the operation of the SVRS. The SVRS and any valves must be installed strictly according to the manufacturer's recommendations.
- Although some SVRS devices shut off the pump, the pump might turn back on unexpectedly.

Maintenance drains and fire suppression source outlets are new to the 2017 edition of ANSI/APSP/ICC-16 and they are only to be used when the POOL is closed to users. These can be STANDARD, commercially available SOFAs, and they are only intended to guard the non-flowing pipe opening when the POOL is in use.

Floor (horizontal) orientation flow ratings are typically higher than when the same SOFA is installed in the wall (vertical) orientation.

4.7.1.6.4 Flow Distribution and Control

The 125% of the total recirculation flow rate chosen by the designer is recommended as part of the hydraulic flexibility recommendation in MAHC Annex 4.7.1.1. The proportioning valve*(s)* are recommended to restrict flow by increasing the head loss in the pipe*(s)* typically on the main drain lines where flow rates are less than those from the surface overflow system lines. The main drain system shall be designed at a minimum to handle recirculation flow of 100% of total design recirculation flow rate. A minimum of two hydraulically balanced filtration system suction outlets are required as protection from suction entrapment. The branch pipe from each main drain outlet shall be designed to carry 100% of the recirculation flow rate so if one drain outlet is blocked, the other has the capacity to handle the total flow. Where three or more main drain outlets are connected by branch piping in accordance with MAHC 4.7.1.6.4.1.2, it is not necessary that each be designed for 100% flow. Where three or more properly piped drain outlets are provided, the design flow through each drain outlet may be as follows:

- Q_{max} for each drain= Q (*total recirculation rate*) / (*number of drains less one*)
- $Q_{max}=Q_{total}$ / *(N-1)*

The result is that if one drain is blocked, the remaining drains will cumulatively handle 100% of the flow.

Example:

- Q_{total} = 600 GPM recirculation rate
- N = 3 drains
  600 / (3-1) = 300 GPM / drain.

4.7.1.7 Piping

4.7.1.7.2 Velocity in Pipes

4.7.1.7.2.1 Discharge Piping

RECIRCULATION SYSTEM piping should be designed so the water velocities should not exceed 8 feet *(2.4 m)* per second on the discharge side of the recirculation pump. This is a maximum value as opposed to a good design value. The head loss in a pipe *(and hence the energy loss in the RECIRCULATION SYSTEM)* is proportional to the square of the velocity in the pipe *(i.e., if you cut the velocity in half, then you reduce the head loss to ¼ (25%) of the original value)*. In the interest of conserving energy, velocities in the range of 6 to

8 *feet (1.8 m to 2.4 m)* per second are recommended. Without a minimum INLET velocity, uniform water distribution within the supply piping will not happen.

4.7.1.7.2.2 Suction Piping

The maximum velocity in suction piping is 6 feet *(1.8 m)* per second. The real limitation in suction piping is Net Positive Suction Head (NPSH) recommended by the pump. NPSH refers to the pressure energy at the suction INLET to the impeller. Pump problems can result from incorrect determination of NPSH. Inadequate NPSH can reduce pump efficiency and capacity and lead to cavitation. If cavitation continues and the pump conditions deteriorate, vibration problems can lead to destruction of the pump impeller and damage to other pump hardware. Failure to provide sufficient NPSH for the pump can result in cavitation, high power usage, and premature failure of the pump and other RECIRCULATION SYSTEM components. The velocities recommended could be lower depending on the size and configuration of the piping as well as the elevation and water temperature. The available NSPH should be at least 20% greater than the recommended NPSH. The available NPSH should be calculated for each AQUATIC VENUE pump and each AQUATIC FEATURE pump. The available NPSH should be compared with the NPSH recommended by each pump manufacturer. Cavitation will occur if the available NPSH is less than the recommended NPSH. The available NPSH is calculated as follows *(all terms in feet)*:

Absolute pressure on the liquid surface

– friction losses in the suction line

– vapor pressure of the water

+ static head of liquid above impeller eye.

Hydraulic calculations for piping and pumps should be prepared by a qualified engineer.

4.7.1.7.2.3 Additional Considerations

Gravity piping must be sufficiently sized to accommodate the recommended flow *(including surges)* without water surcharging above the INLET. Careful consideration of available head, the head losses, and the combined flow from multiple inputs into a single pipe is a necessity. The 2 feet *(61.0 cm)* per second value is a value derived from common practice with no clearly identifiable theoretical basis.

4.7.1.7.3 Drainage and Installation

Draining Recommendation

The draining recommendation for all equipment and piping serves multiple functions. First, any sediment or rust particles that gather in the pipe can be flushed by means of the drainage system. Since bacteria and biofilms are mostly water, drying out a biofilm can be an effective means of controlling growth. Whereas leaving a pipe full of water during a period of maintenance or no use could lead to dissipation of the CHLORINE residual and proliferation of a biofilm inside of pipes or equipment. Biofilms can lead to bio-corrosion of metal components of the RECIRCULATION SYSTEM and serve as protection for microbes and pathogens.

Designed

All equipment and piping should be designed and constructed to drain completely by use of drain plugs, drain valves, or other means. All piping should be supported continuously or at sufficiently close intervals to prevent sagging and settlement. All suction piping should be sloped in one direction, preferably toward the pump. All supply and return pipelines to the AQUATIC VENUE should be provided to allow the piping to be drained completely.

Individual Drain

The individual drain to facilitate emptying the POOL in case of an accidental gross contamination event is intended to prevent further contamination of any pipes, pumps, multi-port valves, filters, or other equipment associated with the RECIRCULATION SYSTEM, which might be more difficult to clean than the inside of the AQUATIC VENUE. In the case of combined AQUATIC VENUE treatment systems, this drain could prevent cross-contamination of multiple AQUATIC VENUES.

4.7.1.7.4 Piping and Component Identification

4.7.1.7.4.1 Clearly Marked

Clearly marking pipes will prevent misidentification that could lead to CROSS-CONNECTIONS and contamination of the AQUATIC VENUE. Pipe marking will also facilitate easier identification of locations for additional equipment installation or sample lines.

Color Coding Recommendations: Pipes and valves, when color-coded, may be color-coded in accordance with the following:

- Potable water lines *(Dark blue)*,
- Backwash waste *(Dark brown)*,
- Filtered water *(Aqua)*,
- Sewer *(Dark gray)*,
- SKIMMER or gutter return *(Olive green)*,
- DECK drains *(Light brown)*,
- Main drain *(Black)*,
- Alum *(Orange)*,
- CHLORINE (gas/solution) *(Yellow)*,
- Compressed air *(Dark green)*,
- Soda ash *(White)*,
- Gas *(Red)*, and
- Acid *(Pink)*.

4.7.1.8 Strainers and Pumps

4.7.1.8.2 Pumping Equipment

4.7.1.8.2.1 Variable Frequency Drives

VFDs may be allowed because the energy savings could be substantial if flow is reduced at night and water quality criteria are continuously maintained. At this time, we are not aware of public health benefits or deficits associated with VFD use so these pumps are allowed but not required. Operators should be aware that VFDs can flatten out a pump curve so if they are installed on a filter pump, operators might want more active control to maintain operations. It is recommended that operators use VFDs with a compatible flow meter with a feedback control to optimize VFD function.

4.7.1.8.2.2 Total Dynamic Head

The recirculation pump should be selected to meet the recommendations of the designer for the system. However, the following guidelines are suggested as starting points for designers. The recirculation pump(s) must be selected to provide the recommended recirculation flow against a minimum TDH of the system, which is normally at least 50 feet *(15.2 m)* for all vacuum filters, 70 feet *(21.3 m)* for granular media and cartridge filters, or 60 feet *(18.3 m)* for precoat filters. A lower TDH could be shown to be hydraulically appropriate by the designer by calculating the total head loss of the system components under worst-case conditions.

4.7.1.8.3 Operating Gauges

Pressure Measurements

A second set of pressure measurement ports could be recommended *(tapped into the pump volute and discharge casing)* to accurately calculate the flow of the pump. These gauges are a way of verifying the pump curve is correct. One can also use the pressure/vacuum gauges and pump curve to verify the flow meter reading and look for differences between the two. During startup, it is possible to shut off a valve on the discharge side of the pump and verify that the maximum discharge pressure measured agrees with the value on the pump curve.

It is recommended that all pumps be located on a base to be easily accessible for motor service.

Vacuum Limit Switches

The vacuum limit switch is intended to shut down the pump if the vacuum increases to a point which could cause damage to the pump *(cavitation)*.

4.7.1.9 Flow Measurement and Control

4.7.1.9.1 Flow Meters

During the almost 100,000 *(99,595)* inspections conducted in Florida during July 1, 2020–June 30, 2021, inspectors identified 13,928 flow meter violations (State of Florida*, public record report available by request*). Of the 185,323 violations identified during this calendar year, 7.5% were flow meter violations. This section of the MAHC is intended to improve this flow meter reliability *problem (as well as to address a problem with accuracy)*. Since flow rates are critical for proper filtration, sizing, and operational calculations, it is recommended that operators purchase a more accurate flow meter for all systems or when replacing older flow meters on their existing system. Improved accuracy improves an operator's chance of understanding the true flow in their system. Operators should be mindful of flow meter placement by installing according to manufacturer recommendations and adhering to recommended distance parameters. A flow meter or other device that gives a continuous indication of the flow rate in GPM *(L/min)* through each filter should be provided. If granular media filters are used, a device should be provided to measure the backwash flow rate in GPM *(L/min)* for each filter. Flow meters should have a measurement capacity of at least 150% of the design recirculation flow rate through each filter, and each flow meter should be accurate within +/-5% of the actual design recirculation flow rate. The flow measuring device should have an operating range appropriate for the anticipated flow rates and be installed where it is readily accessible for reading and routine maintenance. Flow meters should be installed with 10 pipe diameters of straight pipe upstream and five pipe diameters of straight pipe downstream or in accordance with the manufacturer's recommendations. Acrylic flow meters will not meet the accuracy requirement *(and are prone to fouling/clogging)* and hence should not be installed as the primary flow meter on any RECIRCULATION SYSTEM. However, acrylic flow meters could prove useful as a backup or auxiliary flow meter. It is important to note that for acrylic flow meters, even when installed correctly, error must be considered before evaluating TURNOVER RATE or drain cover adequacy using a measurement from that type of flow meter. The QUALIFIED OPERATOR should consult the specifications or instructions for the flow meter to determine the error that must be considered. A paddle-wheel flow meter, when used, should be located on the effluent side of the filter to prevent fouling.

More accurate flow meters are recommended to conserve energy and increase regulatory compliance. Magnetic and ultrasonic flow meters offer greater accuracy *(typically less than +/- 1% error)* and less potential for fouling, but the aforementioned flow meters tend to be more expensive (e.g., $1,000 or more). An ultrasonic flow meter *(such as clamp-on transit-time models)* can be used to measure flows through the wall of a pipe, so they can be installed and uninstalled without modifying the existing plumbing. One ultrasonic flow meter could be used to routinely verify the flow readings of multiple other flow meters that are more prone to error. An annual cleaning and evaluation of flow meter accuracy could be useful in maintaining compliance with existing regulations.

4.7.1.10 Flow Rates / Turnover

The volume, BATHER load, and use of the POOL determine the reasons for different maximum TURNOVER RATES based on POOL type and use. For example, an INCREASED RISK AQUATIC VENUE, such as a WADING POOL, typically has diaper-aged PATRONS who are both immunosensitive and high contaminators as there is a lower water volume to BATHER ratio. Due to the high contamination load, the water in the POOL should be turned over (filtered and disinfected) at a quicker rate. A DIVING POOL can have a longer maximum TURNOVER RATE due to the lower water volume to BATHER ratio and lower risk of contamination.

4.7.1.10.2 Calculated

A new methodology is being proposed for use in the future that calculates the recommended minimum design recirculation flow rate, which is called the maximum sustainable BATHER load *(MSBL)* calculation. The MSBL calculation is based on the values in MAHC Annex Table 4.7.1.10.2 *(below)* and adjusted by all applicable multipliers in MAHC Annex Table 4.7.1.10.3 *(below)* as the maximum TURNOVER TIME allowable based on the pathogen load and CHLORINE demand imparted by BATHERS, whereas the traditional TURNOVER TIME values *(required in MAHC Table 4.7.1.10 above)* are based on physical transport processes of

CONTAMINANTS and DISINFECTANT in the POOL. The MSBL design TURNOVER RATES should use the adjustment factors provided. For mixed-use POOLS, each zone of the POOL should individually meet the recommended TURNOVER TIME for the zone based on the lesser TURNOVER TIME calculated by the procedures already described. All the maximum TURNOVER TIMES provided in MAHC Table 4.7.1.10 are required for AQUATIC VENUES as defined in the MAHC. The MSBL values calculated might help to identify POOLS that could be slightly over-designed to meet the demands placed on the AQUATIC VENUE. Furthermore, the MSBL approach identifies risk factors that might require higher or lower levels of treatment based on the actual system.

- ***Zone Volume*** (ft^3) = Zone Surface Area (ft^2) x Average Depth (ft)

- ***Zone BATHER Load Factor*** (BATHERS/ft^3) =
  1 / {Surface Area per BATHER (ft^2/BATHER)} x (Average Depth (ft))

- ***Estimated Maximum Number of BATHERS Per Zone*** =

  Zone BATHER Load Factor (BATHER/ft^3) x Zone Volume (ft^3)

- ***Raw Recirculation Flow Rate Per Zone*** (gal/min) =
  Estimated Maximum Number of BATHERS Per Zone x 5.34 *(This constant is based on PWTAG multiplier and is approximately 29% smaller and less conservative. See text following Table 4.7.1.10.4.)*

- ***TURNOVER TIME*** (h) =
  Water volume (gal) / {Recirculation rate (gal/min) x (60 min / 1 hr)}

Table 4.7.1.10.2: Bather Loading Estimates

Water Depth	Surface Area Per Bather
<3 feet *(0.9 m)*	25 ft^2 *(2.3 m^2)*
3–6 feet *(0.9 m to 1.8 m)*	30 ft^2 *(2.8 m^2)*
6.1–10 feet *(1.9 m to 3.0 m)*	22 ft^2 *(2.0 m^2)*
Over 10.1 feet *(3.1 m)*	16 ft^2 *(1.5 m^2)*

Table 4.7.1.10.3: Recirculation Rate Multipliers (Adjustment Factors)

Adjustment Reason	Adjustment Factor	Recommendation(s)
Edge Loading *(more bathers at edge of larger pools)*	1.1	Pools must be greater than 100,000 gallons *(378,500 L)* Spas must be greater than 10,000 gallons *(37,900 L)*
Increased-Risk *(diaper-aged patrons present)*	0.75	Pool designed for at least 10% of patrons to be diaper aged.
Activity / Line *(attractions increase bather density)*	0.5	Any pool/spa with an associated ride or activity *(besides swimming)* or line to enter
High-Temperature *(increased sweat production)*	0.5	Pool/Spa with water temperatures routinely exceeding 95 F.
Indoor *(protected from some environmental factors)*	1.15	Pool/Spa must be located completely indoors year-round.
Limited-Use *(pools that are frequently lightly loaded)*	1.33	Pool must be at an Apartment, Condominium, or Hotel/Motel with no associated attraction or activity.
Showering Recommended *(showering reduces bather load)*	1.15	Pool/Spa must recommend showering prior to entry.

Example Calculation

For example, here is a set of example calculations for an indoor POOL in a hotel that is 20 feet *(6.1 m)* wide by 30 feet *(9.1 m)* long with an even floor slope that goes from 4 feet *(1.2 m)* at the shallow end to 6 feet *(1.8 m)* at the deep end.

- ***Zone Volume*** (ft^3)
  = 20 ft x 30 ft x 5 ft = 3,000 ft^3

- ***Zone BATHER Load Factor*** (BATHERS/ft^3)
  = 1/ (30 ft^2/BATHER) x (5ft) = 0.00666 BATHERS/ft^3

- ***Estimated Maximum Number of BATHERS Per Zone***
  = 0.00666 BATHER/ft3 x 3,000 ft^3 = 20 BATHERS

- ***Raw Recirculation Flow Rate Per Zone*** (gal/min)
  = 20 BATHERS x 5.34 = 106.8 gal/min

- ***TURNOVER TIME*** (h)
  = 3,000 ft^3 x 7.48 gal/ft^3/ (106.8 gal/min) x (60 min/1 hr) = 3.5 h

- ***Adjustments for indoor POOL and limited use POOL***:
  3.5 h x 1.15 x 1.33 = 5.35 h

Compare the MSBL value of 5.35 hours to the value in MAHC Annex Table 4.7.1.10.3 of 5 hours and use the lower value = 5 hours. Additional example calculations are provided in MAHC Annex Table 4.7.1.10.4.

Table 4.7.1.10.4: Recirculation Rate Calculation Examples by Pool Type Based on Bather Load

Parameter	Large Indoor Pool	Wave Pool	Activity Pool	Spray Pad	Kiddie Pool	Spa	Deep Diving Pool	Small Pool
Volume	322,000 gals. *(1,219,000 L)*	750,000 gals. *(2,839,100 L)*	50,000 gals. *(189,300 L)*	20,000 gals. *(75,710 L)*	1,000 gals. *(3,785 L)*	750 gals. *(2,839 L)*	100,000 gals. *(378,541 L)*	35,000 gals. *(132,500 L)*
Average Depth	7.33 ft. *(2.23 m)*	4.98 ft. *(1.52 m)*	3.00 ft. *(91.4 cm)*	1.00 ft. *(30.5 cm)*	1.00 ft. *(30.5 cm)*	1.50 ft. *(42.7 cm)*	16.00 ft. *(4.88 m)*	5.00 ft. *(1.52 m)*
Surf Area	5870 ft^2 *(545.4 m^2)*	20120 ft^2 *(1,869 m^2)*	2228 ft^2 *(207.0 m^2)*	2673 ft^2 *(248.4 m^2)*	133.7 ft^2 *(12.42 m^2)*	66.84 ft^2 *(6.21 m^2)*	835.6 ft^2 *(77.63 m^2)*	935.83 ft^2 *(86.94 m^2)*
Square Side	76.62 ft. *(23.35 m)*	141.8 ft. *(43.24 m)*	47.20 ft. *(14.39 m)*	51.71 ft. *(15.76 m)*	11.56 ft. *(3.52 m)*	8.18 ft. *(2.49 m)*	28.91 ft. *(8.81 m)*	30.59 ft. *(9.32 m)*
Factor 1 ***(bathers/ft^3)***	0.007346	0.025	0.02	0.04	0.04	0.02667	0.003906	0.00945
Factor 2 ***(bathers/ft^3)***	0.006011	0.00778	0.009445	0.04	0.04	0.02667	0.003906	0.00735
Factor 3 ***(bathers/ft^3)***	0.003821	0.00504	0.009445	0.04	0.04	0.02667	0.003906	0.00655
Total Bathers	219.09	797.52	78.81	106.95	5.35	2.67	52.22	34.93
K	5.34	5.34	5.34	5.34	5.34	5.34	5.34	5.34
GPM Q	1171	4261	421	571	29	14	279	187
Minimum Turnover	275	176	119	35	35	53	358	188
Raw Turnover	4.58	2.93	1.98	0.58	0.58	0.58	5.97	3.13

Parameter	Large Indoor Pool	Wave Pool	Activity Pool	Spray Pad	Kiddie Pool	Spa	Deep Diving Pool	Small Pool
>100K Gallons/Large Pool Edge Load Factor	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Small Pool High Risk Factor	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Activity Pools Density/Line Factor	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
>90°F *(32°C)* Hot Water High Temp. Factor	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Indoor Pools Env. Protect Factor	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Shower Required Bather Load Reduction	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Plain Pools Only: Apartment/ Condo/Hotel Limited Use Factor	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
World Aquatics Turnover *(Hours)*	5.8	1.61	0.99	0.22	0.44	0.22	7.56	4.16
w/ a Required Shower	6.67	1.86	1.14	0.25	0.5	0.25	8.69	4.78
Standard Table Values	4.0-5.0	1.5-2	1-1.5	0.25	0.50	.25-.5	6.0-8.0	5.0

When POOL recirculation rate recommendations are broken down to their essential elements, it is about removing suspended matter *(including microbial CONTAMINANTS)* with the filters and effectively maintaining uniform FREE CHLORINE RESIDUAL at the proper pH. Both the FREE CHLORINE RESIDUAL and the microbial concentrations are a function of the number of BATHERS in a given volume of water. While it is not possible to always accurately predict the BATHER COUNT for a given POOL on a given day, it is generally possible to estimate the maximum number of BATHERS likely to be in any given type of POOL per unit surface area *(since most BATHERS have at least their head above water most of the time and the primary activity in a POOL often dictates the comfort level in regard to BATHERS per unit surface area and hence the likelihood of BATHERS entering or leaving the POOL)*. After establishing a maximum sustainable BATHER load *(MSBL; see Annex 4.7.1.10.2 for further explanation and calculation)* or maximum number of BATHERS expected in a POOL, it is possible to calculate the recommended flow of recirculated water necessary to be treated to handle the pathogen load and CHLORINE demand imparted by the BATHERS. An empirically-derived multiplier was used by PWTAG(116) to convert the MSBL to the recommended recirculation rate. The empirical multiplier used in this CODE was derived independently using English units specifically for use in the United States. The value of the U.S. multiplier is approximately 29% smaller than the PWTAG value using equivalent units because POOL design in the UK is more conservative than in the US.

4.7.1.10.2.1 Unfiltered Water

Unfiltered water shall not factor into TURNOVER TIME. This section is to address/clarify water that might be withdrawn from and returned to the AQUATIC VENUE for such AQUATIC FEATURES as SLIDES, features, etc. by a pump separate from the filtration system. That flow rate from the separate pump system shall not be included in the TURNOVER TIME calculation.

4.7.1.10.3 Turnover Times

The recommended design TURNOVER TIME can then be calculated by dividing the volume by the recommended flow. This procedure can be performed for individual sections of a POOL or the entire POOL depending on the number of zones, which are based on depth of the water. Adjustments can then be made to this calculation to account for extraordinary conditions. For example, since a SPA has higher water temperature than a POOL, a PATRON would be expected to sweat more; an indoor AQUATIC VENUE might experience less contamination from pollen, dust, and rain than an equivalent outdoor AQUATIC VENUE; and an AQUATIC VENUE filled with diaper-age children would be considered an increased-risk AQUATIC VENUE requiring more aggressive treatment. AQUATIC FACILITIES that enforce showering prior to AQUATIC VENUE entry could reduce the organic load on the POOL by 35–60% with SHOWERS lasting only 17 seconds[4]. The BATHER load calculation based on surface area of the POOL has been proposed by PWTAG[116] in 1999 and has influenced the CODES proposed by the World Health Organization[56] and Australia[117]. This approach has been adapted for use in the United States by slightly increasing the area recommended per BATHER in shallow waters and decreasing the area in deep POOLS to account for the intensity of deep water activities, the relatively low surface area to volume ratios of deep waters relative to shallow waters, the typically poorer mixing efficiency in deeper water, the increased amount of time typically spent underwater in deeper water, and the larger average size of BATHERS commonly found in deeper water. These values were empirically derived for the MAHC to match typical U.S. practices and can be changed as necessary to achieve the desired water quality goals.

Effectively handling BATHER COUNT in terms of pathogen removal and CHLORINE demand is a paramount concern for which the above calculations should provide some science-based guidance. However, there are other factors that must be considered when selecting a recirculation rate for an AQUATIC VENUE. For example, effectively distributing treated water to avoid dead spots recommends minimum water velocities to reach the POOL center and extremities. Similarly, effective surface skimming recommends adequate velocities at the surface of the POOL to remove floating CONTAMINANTS. Due to the kinetics of DISINFECTION and CHLORINE decay, CHLORINE must be replenished at some minimum intervals to maintain the recommended FREE CHLORINE RESIDUAL. For these reasons, MAHC Table 4.7.1.10 was developed to provide some maximum TURNOVER TIME limits for AQUATIC VENUES that are not dominantly influenced by BATHER load to help ensure proper physical transport of CONTAMINANTS and DISINFECTANT. Values in this table are derived from historical practice and design experience worldwide. All AQUATIC VENUES must be designed to meet the lesser of the two maximum TURNOVER TIMES.

4.7.1.10.4 Reuse Ratio

This section is intended to address interactive water play venue designs that remove water from the interactive water play treatment tank by an AQUATIC FEATURE pump separate from the filtration system pump. The limit/ratio of interactive water play feature water pump rate to the filtration system water pump rate is to acknowledge the typically high level of contamination and turbidity introduced to the interactive water play treatment tank. The introduction and build-up of turbidity can exceed the rate at which it is removed by the filtration system which can result in interference with chemical DISINFECTION and UV treatment.

4.7.1.10.5 Flow Turndown System

The flow turndown system is intended to reduce energy consumption when AQUATIC VENUES are unoccupied without doing so at the expense of water quality. A turbidity goal of less than 0.5 NTU has been chosen by a number of U.S. state CODES *(e.g., Florida)* as well as the PWTAG[116] and WHO[56]. The maximum turndown of 25% was selected to save energy while not necessarily compromising the ability of the RECIRCULATION SYSTEM to remove, treat, and return water to the center and other extremities of the POOL. The MAHC does not allow stopping recirculation since uncirculated water would soon become stagnant and

loose residual DISINFECTANT likely leading to biofilm proliferation in pipes and filters. This could compromise water quality and increase the risk to BATHERS. Future research could determine that more aggressive turndown rates are acceptable. Some POOLS are already reportedly using the turndown system without a turbidimeter or precise flow rates. The intent of this section is to formalize a system for doing the turndown that does not compromise public health and SAFETY. Additional research in this area could identify innovative ways to optimize and improve this type of system. The likelihood of turbidimeters being cleaned and maintained is likely to be good because turbidimeters tend to give higher reading when not maintained properly. AQUATIC VENUES designed above the minimum design STANDARDS would have the flexibility to increase system flows to maintain excellent water quality during periods of peak activity. The flow turndown system is intended to reduce energy consumption when AQUATIC VENUES are unoccupied without doing so at the expense of water quality. An electronic turbidity and RECIRCULATION SYSTEM flow feedback system would provide a quantifiable means of determining the water quality suitability if a facility desires to "turn down" the recirculation pumps to achieve a flow of up to 25% less than the minimum required recirculation flow rate when the AQUATIC VENUES is occupied. The integration of feedback from both the flow meter and turbidimeter must be maintained for the VFD to be able to reduce the system flow rate below the level required to achieve the TURNOVER TIME requirement.

Variable Frequency Drives

VFDs offer the benefits of energy savings, operational flexibility, and in most cases the ability to automatically increase the pump flow as the filter clogs by interfacing the VFD with a flow meter *(or potentially a filter effluent pressure transducer)* by means of a proportional-integral-derivative *(PID)* controller. VFDs might also offer the added benefits of protecting piping, pumps, and valves. Energy savings and benefits will vary depending on the design of the system.

4.7.2 Filtration

System Design

The filtration system should be designed to remove physical CONTAMINANTS and maintain the clarity and appearance of the AQUATIC VENUE water. However, good clarity does not mean that water is microbiologically safe. With CHLORINE-tolerant human pathogens like *Cryptosporidium*, effective filtration is a crucial process in controlling waterborne pathogen transmission and protecting public health. The filtration system of U.S. AQUATIC VENUES has traditionally been designed to remove physical CONTAMINANTS and maintain the clarity and appearance of the AQUATIC VENUE water. Good clarity is important and will help prevent drowning and underwater collisions. Poor clarity can compromise the DISINFECTION process as well as leaving CHLORINE-tolerant pathogens suspended in the water for longer periods of time. As a future recommendation for discussion, filtration systems should be capable of removing *Cryptosporidium* OOCYSTS or an acceptable 4.5-micron surrogate particle with an efficiency of at least 90% *(i.e., a minimum of 1 log reduction)* in a single pass.

Water Quality

If filtration is poor, water clarity will decline, and drowning risks increase since swimmers in distress cannot be seen from the surface. DISINFECTION will also be compromised, as particles associated with turbidity can surround microorganisms and shield them from the action of DISINFECTANTS. Particulate removal through coagulation and filtration is important for removing *Cryptosporidium* OOCYSTS and *Giardia* cysts and some other protozoa that are resistant to chemical DISINFECTION.[56, 118]

Pathogen Removal

One of the most substantial recommended changes of the MAHC is transitioning the filtration system from one that only provides good clarity and appearance to one that efficiently removes human waterborne pathogens from the AQUATIC VENUE water. Water clarity is only an indicator of potential microbial contamination, but it is the most rapid indicator of possible high contamination levels. CHLORINE residual can be sufficiently high to kill indicator bacteria while leaving protozoa relatively unharmed and infectious. Therefore, testing for indicator bacteria might not be useful as a measure of AQUATIC VENUE water quality, and testing for *Giardia* cysts and *Cryptosporidium* OOCYSTS is very expensive, time-consuming, and cannot be done in real time. So, both measures are impractical as an operational tool for water quality measurement.

Cryptosporidium is a widespread threat responsible for causing outbreaks associated with U.S. AQUATIC VENUES each year.[119, 120] With CHLORINE-tolerant human pathogens like *Cryptosporidium*, effective filtration is a crucial process in controlling waterborne pathogen transmission and protecting public health.[56, 116] Furthermore, an accidental fecal release could overwhelm the DISINFECTANT residual and leave physical removal as the only means of removing pathogens.[56] Filtration has been cited as the "critical step" for the removal of *Cryptosporidium*, *Giardia*, and free-living amebae that can harbor opportunistic bacteria like *Legionella* and *Mycobacterium* species.[56]

Cryptosporidium

Cryptosporidium is a CHLORINE-tolerant protozoan pathogen, and thus, the leading etiology of treated recreational water–associated outbreaks in the United States, particularly outbreaks of acute gastrointestinal illness, as shown in MAHC Annex Figure 4.7.2.1.[119, 121] Surveillance for cryptosporidiosis in the United States indicates that the incidence of reported infection has increased since 2004.[122-126]

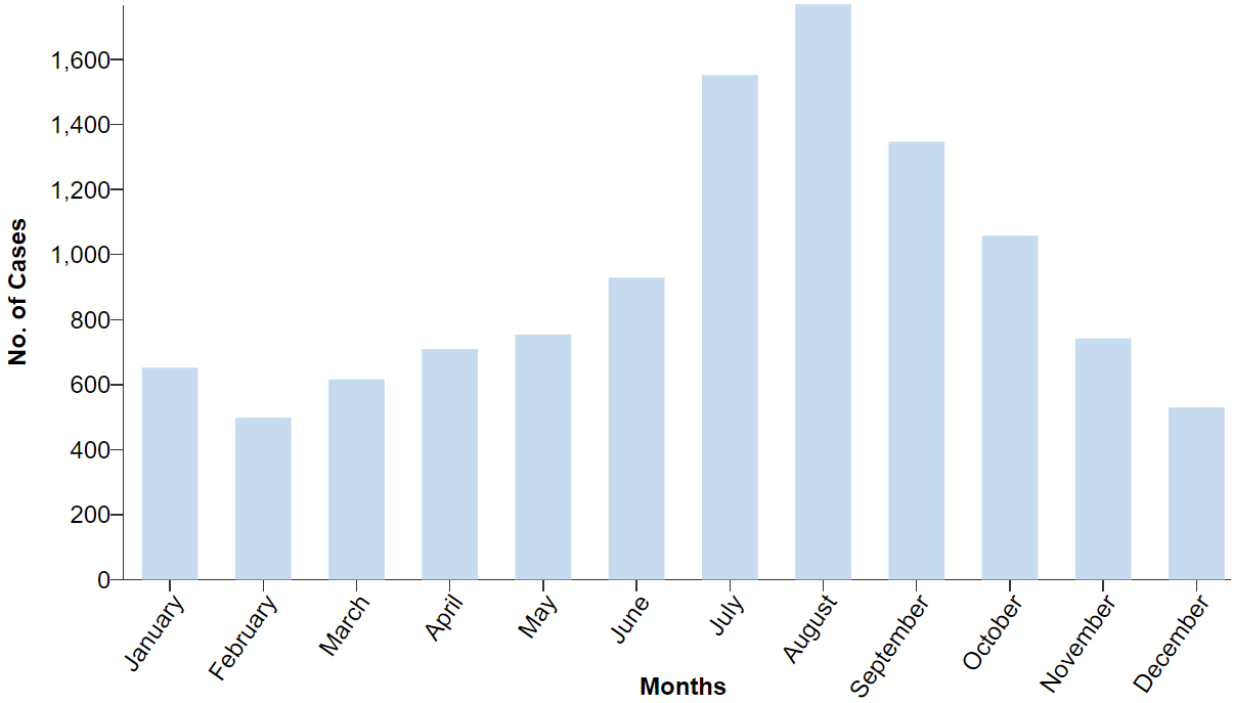
3-Log Reduction

The current CT Values for a 3-log reduction in viability of fresh *Cryptosporidium* OOCYSTS with free CHLORINE are 10,400 mg/L·min *(Iowa-isolate)*[127] and 15,300 mg/L·min *(Maine-isolate)* at pH 7.5.[128] At a concentration of 1 mg/L, free CHLORINE can take more than 10 days to inactivate 99.9% of *Cryptosporidium* OOCYSTS (CT INACTIVATION VALUE *=15,300 mg/L·min)*, but many people are likely to be swimming in the AQUATIC VENUE during that 10-day period and risk being exposed to infective parasite concentrations. Infected individuals might then return to the AQUATIC VENUE or visit other AQUATIC VENUES to amplify the spread of the parasite. Sand filters are commonly used and often serve as the only potential physical BARRIER to *Cryptosporidium* transmission in U.S. AQUATIC VENUES, but sand filters without coagulant typically only remove about 25% of OOCYSTS per passage through the filter[129]. Based on the slow kinetics of CHLORINE inactivation of *Cryptosporidium*, the known inefficiency of sand filter to remove OOCYSTS, and the increased incidence of cryptosporidiosis in the United States, additional measures appear necessary to effectively safeguard public health.

Explanation

MAHC Annex Figure 4.7.2.1 *(below)* shows a dramatic increase in the number of cases of cryptosporidiosis during the warmer months of the year when outdoor public AQUATIC VENUES are normally open in the United States. While it is difficult to assess the prevalence of protozoan parasites in public POOLS during normal operation, a study of 160 filter backwash water samples from Atlanta, GA showed that 8.1% (13) were positive for *Giardia*, *Cryptosporidium* or both[130] while another study of 161 filter backwash samples from metro-Atlanta showed 0.6% (one) and 1.2% (two) were positive for *Cryptosporidium* and *Giardia*, respectively[131, 132].

FIGURE 4.7.2.1: Number of reported cryptosporidiosis cases, by month of symptom onset — National Notifiable Diseases Surveillance System, United States, 2019 (n=11,157*)[118, 124]



* Age data missing for 2,822 patients

Review of Recreational Water Filtration Research Findings

Sand Filters

Sand filters often provide the only physical BARRIER to *Cryptosporidium* in U.S. AQUATIC VENUES, but sand filters meeting the recommendations of pre-existing POOL CODES typically only remove about 25% of OOCYSTS per passage through the filter[129]. A quantitative risk assessment model of *Cryptosporidium* in AQUATIC VENUES confirmed there is a "significant public health risk" from fecal contamination of recreational water[133]. Some changes are necessary to effectively safeguard public health. Recent research in the United States and United Kingdom has shown that sand filters can remove greater than 99% of OOCYSTS per passage when a coagulant is added prior to filtration.[116, 134] , The addition of coagulants to swimming POOL filters used to be common practice in the United States with rapid sand filters, but it fell out of favor as high-rate sand filters began to dominate the U.S. POOL market. The importance of coagulant addition to efficient pathogen removal in drinking water is well-documented and recommended in all U.S. surface water treatment facilities for drinking water production by the EPA.[135-139] The EPA expects drinking water treatment facilities to remove or inactivate a minimum of 99% *(2 log)* of *Cryptosporidium* OOCYSTS and up to 99.997% *(4.5 log)* for facilities treating source water with the highest concentration of OOCYSTS.[136] While more research and quantitative risk assessment models will be recommended to determine the safe level of removal in most AQUATIC VENUES, the current removal rates of approximately 25% can lead to a substantial number of outbreaks each year. Based on the research available for existing AQUATIC VENUE filtration technologies and risk models, a new minimum removal goal for *Cryptosporidium* removal by filters used in new and substantially altered AQUATIC VENUES is recommended to be at least 90% *(1 log)* per single pass.

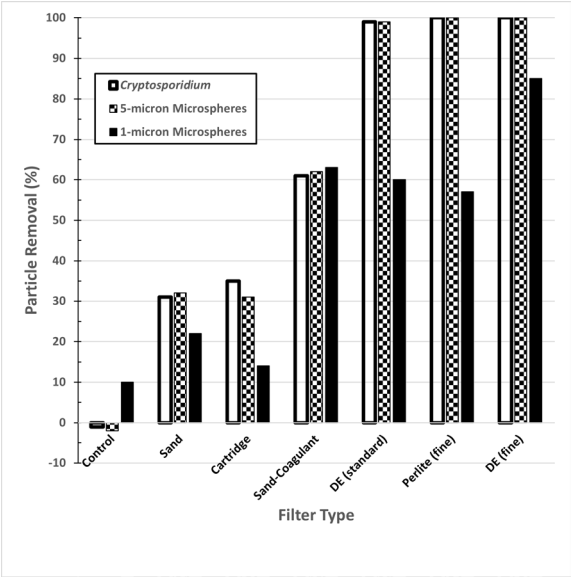
Filtration Systems

Multiple types of AQUATIC VENUE filtration systems have already been shown to achieve removals exceeding 99% depending on the filter design, water quality, and operational variables.

MAHC Annex Figure 4.7.2.2 *(below)* contains a summary of pilot sand filtration treatment research on *Cryptosporidium*-sized microsphere removal via filtration. Bench-scale results were not included due to concerns that the laboratory results might not be reproducible at pilot- or full-scale as has been observed in previous studies. MAHC Annex Figure 4.7.2.2 is sorted in order of increasing filter removal efficiency, and the data is roughly divided into three groupings *(i.e., <90%, 90-99%, and >99% removal)*. Operating conditions falling into the first group would not be expected to reliably meet the new 90% *(single pass)*

removal recommendation that is recommended for all new and substantially altered AQUATIC VENUES. Coagulant dosage, surface loading rate, and media depth can significantly impact filtration removals. The addition of coagulant is beneficial for improving particle removal by POOL sand filters.[140] Careful selection of both design and operating values is essential to achieving excellent pathogen removal with AQUATIC VENUE filters.

Figure 4.7.2.2: Percentage particle removal for each filtration scenario.



Filtration Products

At the time of MAHC development, the following filtration products are believed to be untested for *Cryptosporidium*/4.5-micron carboxylated microsphere removal in AQUATIC VENUE water:

- Regenerative media filters,
- Sand followed by cartridge, *(with 5-micron absolute or 1-micron nominal rating)*,
- Macrolite filter media,
- Charged zeolite media,
- Crushed-recycled glass filter media, and
- Any others not listed in MAHC Annex Figure 4.7.2.2.

Brief Historical Review of Water Filtration Practices for Aquatic Venues

In the United States in the 1920s, rapid sand filters on swimming POOLS were typically operated at 3–5 GPM/ft^2 *(7–12 m/h)* with coagulation prior to filtration, but high-rate sand filters have largely replaced rapid sand filters because they operate at 15-20 GPM/ft^2 *(37–49 m/h)* without coagulant.[141, 142] While high-rate sand filters are definitely cheaper and smaller, they are also less effective at removing *Cryptosporidium*-sized particles. Most U.S. drinking water treatment facilities still use rapid sand filters with coagulation and typically operate them at 3–5 GPM/ft^2 *(7–12 m/h)*. The EPA, after an extensive review of peer-reviewed research, decided to give drinking water treatment facilities credit for removing 99% of *Cryptosporidium* OOCYSTS for properly employing this technology *(i.e., granular media filtration with coagulation prior to filtration)*. Research has shown that high-rate AQUATIC VENUE sand filters can only consistently deliver 22–48% removal of *Cryptosporidium* OOCYSTS or a microsphere surrogate without coagulation[129].

Increased Head Loss Development Rates

Pressure Development

More efficient filtration of AQUATIC VENUE water will, in most cases, lead to higher rates of pressure development in filters and more frequent backwashing of filters. The smaller the pores in the filter media at the surface of the filter, the more rapidly pressure would be expected to increase. Fortunately, there are

multiple options available to design engineers that could reduce the rate of pressure development. These options include:

- The use of more uniformly graded filter media,
- Skimming fines from filter media prior to startup,
- More efficient backwashing of filters,
- Lowering the flow rate per unit surface area, and
- The use of two types of filter media in filters.

4.7.2.1.2 Certified, Listed, and Labeled Filters

Equipment testing of filters to industry STANDARDS is critically important, but it is only one aspect of performance. A filter certified with the hydraulic capability to pass water at 20 GPM/ft^2 *(49 m/h)* does not mean this filter should be operated at 20 GPM/ft^2 *(49 m/h)*. Granular media filters perform better at removing particles and microbes at lower filter loading rates (all other factors equal), and this finding has been repeatedly observed in practice and can be explained theoretically. Filters might need to be held to higher STANDARDS of performance in terms of water quality than the current industry STANDARD. Manufacturers and testing laboratories might need to work together to produce more effective filters and new testing procedures. The maximum filtration rate of 15 GPM/ft^2 *(37 m/h)* is the first step toward a change in filter design STANDARDS aimed at improving microbial removal and preventing RWIs. The MAHC is intentionally more restrictive than the current NSF 50 flow requirements.

4.7.2.2 Granular Media Filters

4.7.2.2.1 General

Design Tip: When a single pump feeds two filters at 10 GPM/ft^2 *(24 m/h)*, redirecting the entire flow through one filter into the backwash line of the other should result in a backwash rate of approximately 20 GPM/ft^2 *(49 m/h)*. The backwash water would be unfiltered water that would have to be plumbed to bypass the filter. With three filters, it would be possible to redirect water from two filters into the backwash influent pipe of the third filter to provide clean backwash water.

4.7.2.2.2 Filter Location and Spacing

Sufficient floor space should be available to accommodate installation of additional filters to increase the original filtration surface area by up to 50% should it be recommended by future regulations or to meet current water quality STANDARDS. This is part of the hydraulic flexibility recommendation of newly constructed POOLS. The idea is to recommend space for additional filters should they become necessary at some point in the future. The 'extra' space could be utilized to make EQUIPMENT ROOMS OR AREAS safer and more functional. A port and ample space for easy removal of filter media is also recommended. Filter media might be changed every 5 years. This process could be exceedingly difficult if filters are not designed with a port for this purpose or if the filters are installed without proper clearance to access the media removal port.

4.7.2.2.3 Filtration and Backwashing Rates

4.7.2.2.3.1 Operate

High-rate granular media filters shall be designed to operate at no more than 15 GPM/ft^2 *(37 m/h)* of filter surface. The minimum depth of filter media above the under-drains (or laterals) shall be set by the filter manufacturer. Filters with bed depths less than 15 inches *(38.1 cm)* shall operate at no greater than 12 GPM/ft^2 *(29 m/h)* of filter surface area. A minimum bed depth of 15 inches *(38.1 cm)* is required for flow rates greater than 12 GPM/ft^2 *(29 m/h)* to a maximum of 15 GPM/ft^2 *(37 m/h)*. Note: Allowable filter rate is directly related to bed depth. The granular media filter system should be designed to backwash each filter at a rate of at least 15 GPM/ft^2 *(37 m/h)* of filter bed surface area, unless explicitly prohibited by the filter manufacturer. Specially graded filter media should be recommended in filter systems backwashing at less than 20 GPM/ft^2 *(49 m/h)* to be able to expand the bed at least 20% above the fixed bed height at the design backwash flow rate, which is subject to approval by the AHJ. Filtration and backwashing at the same flow rate is likely to lead to poor performance of both processes. Backwashing at double the filtration rate is not all that complicated with a 3-filter system, where the flow of two filters is used to backwash the third. Further, backwashing with unfiltered water is possible in a 2-filter system by backwashing with the entire recirculation

flow through each filter individually. Variable drive pumping systems and accurate flow meters also contribute to the likelihood of successful backwashing as well as effective filtration.

Effective Filtration

Filtration at 10 GPM/ft^2 *(24 m/h)* is really pushing the envelope for attaining effective filtration and would not be recommended for a municipal drinking water system using sand filters due to doubts about the ability of such a filter to remove particulate CONTAMINANTS reliably. There are instances where multi-media deep bed filters or mono-media filters with large diameter anthracite and 6 foot *(1.8 m)* deep or greater beds of media are used, such as those owned and operated by the Los Angeles Department of Water and Power. Effective filtration of drinking water at high filtration rates recommends careful and exact management of coagulation. Whereas filtration rates are not explicitly addressed in much of the research on water filtration, the experience of researchers, regulators, and consultants is that high-rate filtration recommends extra attention and talent. For example, over 3 decades ago, the State of California allowed the Contra Costa Water District to operate filters at 10 GPM/ft^2 *(24 m/h)* but other water utilities were not allowed to do this. The exception was permitted because of the design and the high level of operating capability at the plant where the high rate was used. Operation at very high rates either causes very rapid increases of head loss in sand filters (water utility experience resulted in the conclusion that operating sand filters at rates above 3 or 4 GPM/ft^2 *(7–10 m/h)* was impractical) or very little particle removal occurs as water passes through the sand bed, thus enabling filters to operate for a long time at high rates. For this reason, following World War II, the use of anthracite and sand filters became the norm for filters designed to operate at 4 or 5 GPM/ft^2 *(10-12 m/h)* or higher. Finally, in the 1980s, workers in Los Angeles showed that a deep *(6-foot [1.8 m])* filter with 1.5 mm effective size anthracite media could effectively filter water at rates of close to 15 GPM/ft^2 *(37 m/h)*. However, for very high rates of filtration to be effective, pretreatment must be excellent, with proper pH and coagulant dosage, probably use of polymer, and in some cases, use of a pre-oxidant to improve filter performance. This is well understood by filter designers and professors who specialize in water filtration. Articles published on the Los Angeles work done by James Montgomery Engineers showed the importance of proper pretreatment. Papers written by experts on filtration have noted the importance of effective pretreatment *(including proper coagulation)* for dependable filter performance, and those writers were focused on rates employed in municipal filtration plants *(e.g., 3–10 GPM/ft^2 (7-24 m/h))*. As filtration rate increases, water velocity through the pores in the sand bed increases, making it more difficult for particles to attach to sand grains and remain in the bed instead of being pushed on through the bed and into filter effluent. When filters do not work effectively for pathogen removal, the burden is put on DISINFECTION to control the pathogens. For *Cryptosporidium*, the DISINFECTION approach that is typically most cost-effective is UV, so a very high-rate filter might need to be followed by UV for pathogen inactivation, and the very high-rate filters would just have to clarify the water sufficiently that there is no interference from particulate CONTAMINANTS with the UV inactivation process.

4.7.2.2.3.2 Backwash System Design

For a granular media filter system to be able to backwash at a rate of at least 15 GPM/ft^2 *(37 m/h)* of filter bed surface area, the pump*(s)*, pipes, and filters must be designed accordingly. As many professionals have sought to improve water quality by decreasing the filtration rate to values lower than 15 GPM/ft^2 *(37 m/h)*, they have sometimes failed to recognize that while lowering the filtration rate may generally produce a positive change in performance, a similarly lower backwash rate could lead to a total filtration system failure. In cases where a backwash rate of 15 GPM/ft^2 *(37 m/h)* is explicitly prohibited by the filter manufacturer, the filter might still be used, provided that specially graded filter media is installed that will expand to a minimum of 20% bed expansion at the specified backwash flow rate. Viewing windows are highly recommended in all filters since they will allow direct observation of the bed expansion during backwashing, cleanliness of the media and backwash water, and the depth of the sand in the filter. Croll and coworkers[134] used a backwashing rate of 25 GPM/ft^2 *(61 m/h)* to achieve 25% bed expansion of their filter.

WHO Recommendations

The WHO recommends a backwash rate of 15-17 GPM/ft^2 *(37-42 m/h)* for sand filters, but the media specifications are not given nor is it clear if air-scour is expected prior to backwashing.[56] Backwashing swimming POOL sand filters with air scour is common in the UK and elsewhere.[56, 116] It has also been reported that air-scour washed AQUATIC VENUE filters are more efficient than filters washed by water

only.[143] It is reasonable that lower backwashing rates would be used for water backwash when following air-scour since the air-scour dislodges most of the particles attached to the media grains *(as opposed to relying on the sheer force of the water passing over the surface of the particles)*. It is not feasible to operate sand filters in drinking water treatment plants without an auxiliary backwash system such as air scour.[144] The practice of operating AQUATIC VENUES and filters *(that were not using coagulation)* without air scour has been STANDARD practice in the United States for many years, which has seen mixed results ranging from no problems to total system failures requiring replacement of all filter media. PWTAG recommends air-scouring filters at 32 m/h *(13 GPM/ft^2) (at 0.35 bar)*.[116]

Polyphosphate Products

Polyphosphate products are sometimes used to sequester metals in POOLS, but this practice is not recommended when granular media filters are used because polyphosphate is an effective particle dispersant that can reduce the removal efficiency.

Filter Bed Expansion

Sufficient freeboard *(or space between the top of the media and the backwash overflow)* to allow for a minimum of 35% filter bed expansion during backwashing adds a factor of SAFETY when the target bed expansion is 20% to prevent the washout of filter media during backwashing. The regions underneath the lateral underdrains in granular media filters can become stagnant when filled with sand or gravel, which can lead to low DISINFECTANT residuals and ultimately biofilm growth. Filling this area with concrete at the time of installation may prevent this potential problem.[116] It is fundamentally difficult to suspend *(i.e., fluidize)* and hence clean filter media or gravel that is below the level where the backwash water enters the filter.

4.7.2.2.4 Minimum Filter Media Depth Requirement

The performance of high-rate granular media filters at removing pathogens and particles is contingent upon the depth of the filter media *(as shown in MAHC Annex Table 4.7.2.1)*, especially at rates of 15 GPM/ft^2 *(37 m/h)*, which is why these filters recommend at least 24 inches *(61.0 cm)* of filter media. The WHO recommends filtration at 10-12 GPM/ft^2 *(24-29 m/h)* for sand filters while the PWTAG recommends 4-10 GPM/ft^2 *(10-24 m/h)* as the maximum filtration rate for all non-domestic POOLS using sand filters.[56, 116] The STANDARD sand filter bed depth typically varies from 0.55–1 m *(22–39 inches)* in the UK.[116]

Minimum Depth

For swimming POOL filters with less than 24 inches *(61.0 cm)* of media between the top of the laterals and the top of the filter bed, lower filtration rates *(e.g., 10 GPM/ft^2 [24 m/h])* are recommended to efficiently remove particles and pathogens. Improvements in particle removal with decreasing filtration rates have been documented.[145] Drinking water treatment facilities typically limit filtration to less than 4 GPM/ft^2*,(10 m/h)*, which is similar to the filtration rates recommended in AQUATIC VENUES in the 1920s.[137, 138] The minimum depth of sand in POOL filters was 36 inches *(0.9 m)* in 1926.[138] Sand filters are typically designed in drinking water treatment for an *L/d* ratio of 1000 or greater, where "L" is the depth of the media and "d" is the diameter of the media grain.[146] For example, a 0.6 mm effective size sand would recommend a minimum 0.6 m *(23.6 inches)* bed depth, and a 12 inch *(30.5 cm)* deep sand bed with 0.5 mm grains would have an *L/d* of only 610. The minimum depth of filter media above the underdrains *(or laterals)* is recommended be 24 inches *(61.0 cm)* or greater with sufficient freeboard *(or space between the top of the media and the backwash overflow)* to allow for a minimum of 35% filter bed expansion during backwashing. Sand or other approved granular media should be carefully graded to ensure fluidization of the entire filter bed during backwashing. A design backwash rate of at least 30% higher than the minimum fluidization velocity of the d90 size of the media in water at the larger of 86°F *(30°C)* or the maximum anticipated operating temperature is recommended. A backwash rate higher than the minimum could be necessary to effectively clean the media during backwashing. Variations in the media type, density, water temperature, effective size, or uniformity coefficient might cause changes in the recommended backwash flow rate or bed expansion, which should be subject to approval by the AHJ provided hydraulic justification by the design engineer. Sand or other approved granular media should be carefully graded to ensure fluidization of the entire filter bed during backwashing. The specifications of POOL filter sand *(or lack thereof)* can lead to filter media being installed that cannot be effectively cleaned during backwashing. Sand that cannot be properly cleaned can lead to filter

failures or biofilms in the bottom of a filter. Researchers have found nematodes, rotifers, ciliates, zooflagellates, amoebic trophozoites and cysts, as well as bacterial masses in the backwash water of swimming POOL sand filters.[130, 132, 147] A design backwash rate of at least 30% higher than the minimum fluidization velocity of the d90 size of the media in water at the larger of 86°F *(30°C)* or the maximum anticipated operating temperature is recommended, but a backwash rate higher than the minimum could be necessary to effectively clean the media during backwashing. These backwashing recommendations are based on drinking water treatment practice.[146] For a sample of AQUATIC VENUE filter sand examined at University of North Carolina–Charlotte, the d90 size *(i.e., 90% of the grains smaller than this diameter)* of the media was estimated from the sieve analysis results in MAHC Annex Figure 4.7.2.1.4.1 *(below)* to be 1.06 mm. The calculated minimum fluidization velocity of this sized sand grain in water at 86°F *(30°C)* was calculated to be 16.7 GPM/ft^2 *(41 m/h)*. Since this backwash velocity would be expected to leave approximately 10% of the grains in the filter that were larger than the d90 unfluidized, common practice is to recommend a backwashing rate 30% greater than this minimum value *(or 21.7 GPM/ft^2) (53 m/h)*. The recommended backwash flow for this media by Kawamura[148] was graphically estimated to be 20.9 GPM/ft^2 *(51 m/h)* at 68°F *(20°C)*. This is the rationale for requiring at least a 15 GPM/ft^2 *(37 m/h)* backwashing rate of all swimming POOL sand filters. To ensure compatibility with the minimum recommended backwashing rate of 15 GPM/ft^2 *(37 m/h)*, filter sand should pass through a number 20 U.S. STANDARD sieve or equivalent *(i.e., all sand grains should be smaller than approximately 0.85 mm)*. While this recommendation of "#20 Silica sand" is common in swimming POOL manuals and by filter manufacturers, it does not appear to be representative of the actual sand that might be installed. Sieve analyses of two brands of commercially available "POOL filter sand" are provided in MAHC Annex Figures 4.7.2.2.4.1 and 4.7.2.2.4.2. Sand can also be specified by an effective size *(E.S.)* of 0.45 mm with a uniformity coefficient *(U.C.)* of less than or equal to 1.45, which is roughly equivalent to a 20/40 mesh sand. A 20/40 mesh sand would pass through a #20 *(0.85 mm)* sieve and be retained on a #40 *(0.42 mm)* sieve. To reduce the rate of head loss accumulation at the top of the filter bed *(and the frequency of backwashing)*, a 20/30 mesh sand could be specified where the smallest grains at the top of the filter would be approximately 0.60 mm *(30 mesh)* instead of 0.42 mm *(40 mesh)*.

Figure 4.7.2.2.4.1: Grain Size Distribution of Pool Filter Sand – Brand A

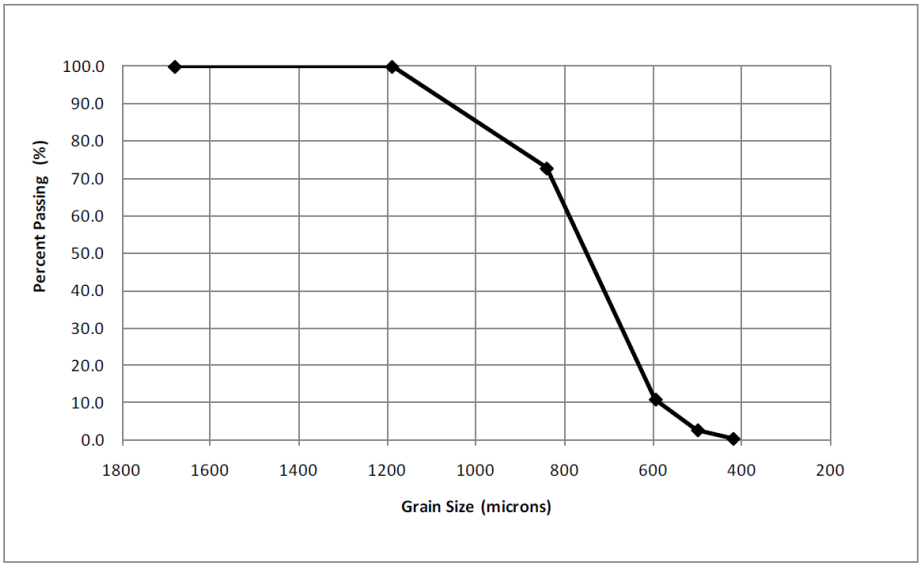
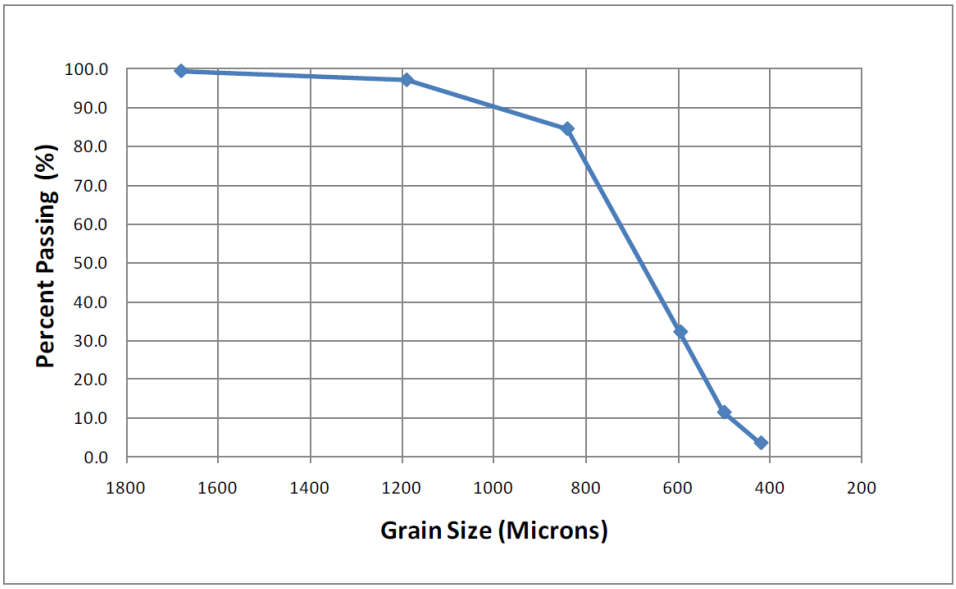


Figure 4.7.2.2.4.2: Grain Size Distribution of Pool Filter Sand – Brand B



The depth of the expanded bed during backwashing should be at least 20% greater than the depth of the fixed bed after backwashing. Experiments to determine the backwashing rates recommended to fluidize a bed of POOL filter sand in 3-inch *(7.6 cm)* and 6-inch *(15.2 cm)* diameter clear PVC filter columns based on visual observation were conducted. Fluidization is somewhat subjective when observed visually because sand grains could be moving sluggishly prior to fluidization and because the smaller grains at the top of the filter will fluidize long before the larger grains at the bottom. For this reason, bed expansion was measured and recorded along with visual observations of when the bed actually fluidized. Fluidization was visually observed to occur between 20 and 23 GPM/ft^2 *(49–56 m/h)*, which coincided with 19–23% bed expansion in both sized columns for the unaltered commercial filter media at 68°F *(20°C)*. Expansion data from the 3-inch *(7.6 cm)* diameter filter column is shown in MAHC Annex Table 4.7.2.2.4.3 *(below)*. The 20/30 mesh fraction of the same filter media was examined under the same conditions, and the experimental results are provided in MAHC Annex Table 4.7.2.2.4.4. The media was observed to be fully fluidized at 19.9 GPM/ft^2 *(49 m/h)* with a bed expansion of 21.8% at 68°F *(20°C)*. Calculations based on Cleasby and Logsdon[146] indicate that filter backwashing rates should increase by approximately 18% for this media as the temperature is increased from 68° to 86°F *(20° to 30°C)* due to changes in the viscosity of water with temperature. Fluidization can be somewhat complicated to estimate, but filter bed expansion can be measured in the field with granular media filters that use viewing windows. Furthermore, a model exists that can be used to calculate filter bed expansion of sand in a filter during backwashing.[149] This model tends to be sensitive to fixed bed porosity, but using a value of 42% porosity with a sphericity of 0.85 and density of 2.65 g/cm^3 yielded a bed expansion of 22.7% at 20 GPM for water at 86°F *(30°C)*. This is the rationale for requiring the depth of the expanded bed during backwashing being at least 20% greater than the depth of the fixed bed. PWTAG recommends 15-25% bed expansion following air scouring at 32 m/h *(13 GPM/ft^2) (at 0.35 bar)*.[116] In a study funded by PWTAG, researchers used a backwashing rate of 25 GPM/ft^2 (61 m/h) to achieve 25% bed expansion of their filters.[116] Variations in the media type, density, water temperature, effective size, or uniformity coefficient might cause changes in the recommended backwash flow rate or bed expansion, which should be subject to approval by the AHJ provided hydraulic justification by the design engineer.

Table 4.7.2.2.4.3: Pool Filter Sand at 68°F (20° C)

Backwash Flow	Bed Expansion
12.4 GPM/ft^2 *(30.3 m/h)*	3.6%
16.3 GPM/ft^2 *(39.8 m/h)*	11.4%
18.5 GPM/ft^2 *(45.2 m/h)*	16.3 %
20.3 GPM/ft^2 *(49.6 m/h)*	19.3%
22.1 GPM/ft^2 *(54.0 m/h)*	22.5%

Table 4.7.2.2.4.4: Pool Filter Sand Sieved 20/30 mesh at 68°F (20° C)

Backwash Flow	Bed Expansion
12.2 GPM/ft^2 *(29.8 m/h)*	4.8%
15.8 GPM/ft^2 *(38.6 m/h)*	13.0%
17.9 GPM/ft^2 *(43.8 m/h)*	17.4 %
19.9 GPM/ft^2 *(48.6 m/h)*	21.8%
21.5 GPM/ft^2 *(52.6 m/h)*	25.6%
23.9 GPM/ft^2 *(58.4 m/h)*	31.2%

4.7.2.2.6 Coagulant Injection Equipment Installation

To enhance filter performance, a coagulant feed system, when used, should be installed with an injection point located before the filters and, for pressure filters, on the suction side of the recirculation pump*(s)* capable of delivering a variable dose of a coagulant *(e.g., polyaluminum chloride or a POOL clarifier product)* to enhance filter performance. Pumps should be properly sized to allow for continuous delivery of the recommended dosage of the selected coagulant. Products used to enhance filter performance should be used according to the manufacturers' recommendations. The coagulant feed system should consist of a pump, supply reservoir, tubing, isolation valve, and BACKFLOW prevention device. Sand filters used as pre-filters for membranes or cartridge filters with 1-micron nominal or 5-micron absolute size ratings or less should not be recommended to have coagulant injection equipment. Specialized granular filter media capable of removing *Cryptosporidium* OOCYSTS or an acceptable 4.5-micron surrogate particle with an efficiency of at least 90% *(i.e., a minimum of 1 log reduction)* without coagulation should not be recommended to provide coagulant injection equipment, but this media should be replaced or reconditioned as recommended to sustain the minimum recommended particle removal efficiency stated above. Sand filters located ahead of a UV or ozone DISINFECTION system may be excluded from supplying coagulation equipment with the approval of the AHJ. The AHJ should consider the efficiency of the SECONDARY TREATMENT process for *Cryptosporidium* inactivation but should also consider that a side-stream system does not have any effect on the *Cryptosporidium* OOCYSTS that bypass the system on each TURNOVER. For example, a UV system that is 99.999% effective at inactivating *Cryptosporidium* that only treats half of the recirculated water flow is on average only 50% effective *(per pass)* because all the *Cryptosporidium* in the bypass stream remain unaffected by the UV. Coagulation is the key to effective granular media filtration, which has long been recognized in the drinking water industry.(135, 136, 138, 139, 150) Operation of granular media filters without coagulation is not permitted by EPA regulations for drinking water treatment, with the exception of slow sand filters. Thus, if pathogen removal is a goal of water filtration for swimming POOL sand filters, coagulation would be essential. This is the rationale for recommending future consideration of coagulation in swimming POOLS. A coagulant feed system should be installed with an injection point located ahead of the filters to facilitate particle removal by filtration *(instead of settling to the bottom of the POOL)*, and injection ahead of the recirculation pump*(s)* will provide mixing to evenly distribute the coagulant among the particles. A variable dose of a coagulant *(e.g., polyaluminum chloride, or POOL clarifier)* is recommended because coagulant dosages might vary with BATHER load. Products used to enhance filter performance should be used according to the manufacturers' recommendations since overfeed or underfeed of coagulants is known to impair performance. Although polyaluminum chloride *(PACl)* is not a widely used coagulant in the United States at present, it has been used extensively abroad.(116, 150, 151) However, recommended dosages abroad might not be optimized for pathogen removal. PWTAG recommends a polyaluminum chloride dosage of 0.005 mg/L as Al, but research has shown that 0.05 mg/L is recommended to exceed 90% removal and 0.21 mg/L or higher could be optimal with filters operated based on U.K. STANDARDS.(116)

New Challenges: The Impact of Coagulation on Backwashing

Coagulation is likely to make cleaning of sand filters more challenging. Drinking water treatment facilities in the United States employ auxiliary backwash systems such as air-scour to improve the cleaning process. Using water alone for backwashing has not been found to be effective for media cleaning in drinking water treatment applications.(144) Air scour systems are common in European AQUATIC VENUE filters and should be

investigated further in the United States. More frequent backwashing is recommended with water-only backwash, and the clean-bed head loss *(pressure)* should be recorded after each backwash to detect early signs of ineffective backwashing and prevent filter system failures.

Initial Headloss and Headloss Accumulation Rate

Increased head loss *(or pressure buildup)* in filters is expected with coagulation as particles are likely to be removed faster (more efficiently) and closer to the top of the filter thereby clogging the top of the filter more quickly. This is a sign that the coagulation/filtration system is working effectively. The initial head loss after backwashing should remain relatively constant, however. Coagulants have been used successfully in the United States in the past and are currently being used in POOLS abroad.(116, 137, 138, 152) In systems not properly designed to backwash with filter effluent from other filters, the coagulant feed system should not be operated during backwashing so as to prevent introduction of coagulant into the backwash water.

4.7.2.3 Precoat Filters

4.7.2.3.1 Filtration Rates

The design filtration rate of 2.0 GPM/ft^2 *(4.9 m/h)* might be overly conservative and is the same upper limit on filtration rate typically used in drinking water treatment applications.(150) However, drinking water applications typically use finer grades of precoat media at application rates of 0.2 lbs/ft^2 (1 kg/m^2). Lange and coworkers(153) have used filtration rates up to 4 GPM/ft^2 *(10 m/h)* with no adverse effect on *Giardia* cyst removal although the removal of turbidity and bacteria were decreased. Ongerth and Hutton(154) found better removals at 2 GPM/ft^2 *(5 m/h)* than at 1 GPM/ft^2 *(2.4 m/h)* for *Cryptosporidium* OOCYSTS under drinking water treatment conditions *(i.e., 0.2 lbs/ft^2 [1 kg/m^2] of DE with body-feed)*.

4.7.2.3.2 Precoat Media Introduction System Process

The precoat process shall follow the manufacturer's recommendations and requirements of NSF/ANSI Standard 50.

Separation Tank

Precoat filter media has the potential to settle out of suspension in sewer pipes depending on the flow velocities, which could lead to fouling or clogging of sewer pipes. The AHJ may recommend removal of precoat media prior to discharge in sewer systems so POOL operators should check with the AHJ.

4.7.2.3.3 Continuous Filter Media Feed Equipment

Filter performance can be significantly impacted by the selection of the precoat filter media, which could alter water clarity, pathogen removal, and cycle length. Multiple grades of precoat media are available in the marketplace. Precoat media can be specified by median particle size of the media or by permeability of the media.(146)

4.7.2.4 Cartridge Filters

Cartridge filters have not been demonstrated to remove pathogens like *Cryptosporidium* efficiently using the STANDARD swimming POOL cartridges. The non-STANDARDIZED manual cleaning methods for cartridges might lead to pathogen or chemical exposure risks to PATRONS and employees at AQUATIC VENUES, and the fouling of cartridges may lead to AQUATIC VENUES exceeding their maximum recommended TURNOVER TIMES. Poor use of PPE and non-STANDARD cleaning of SPA cartridge filters led to non-tuberculosis mycobacterial infections in SPA workers.(155) Due to these health and SAFETY concerns, cartridge filter use is not recommended in AQUATIC VENUES. Cleaning procedures for cartridges are not well-established and education in proper cleaning procedures is likely necessary to avoid contaminated cartridges being reinstalled into filters potentially providing a protected region for proliferation of biofilm bacteria that could lead to an outbreak. Cartridge filter elements are typically cleaned manually, usually by hosing them down with a water hose and replacing them. Exposure concerns exist since concentrated streams containing *Legionella*, Mycobacteria, *Cryptosporidium*, and other pathogens can potentially be sprayed or splashed around or on the staff and the surrounding environment perhaps even including the inside of the filter or the surfaces surrounding the AQUATIC VENUES. An extensive survey of manufacturers' cleaning recommendations was conducted after there was a legionellosis outbreak in a facility with cartridge filters. *Legionella*,

Pseudomonas, and biofilms were found in the filters. The cleaning procedure employed was to take them outside, rinse them with a water hose, and replace them. Operators reported that they would occasionally degrease or bleach them. Further investigation revealed that this cleaning procedure was common at other facilities. Filter manufacturers were surveyed for cleaning procedures and most often did not have a cleaning process and simply deferred to the cartridge manufacturer since many filter manufacturers do not make the cartridges. The cartridge manufacturers also did not have a cleaning procedure or a very minimal one that did not account for biofilms or heavy organic loads commonly encountered in SPAS. CHLORINE is generally ineffective at inactivating bacteria in a biofilm or removing particulate or organic filter foulants. One effective way to control the biofilms is to completely dry them out.

Based on the known poor performance in removing pathogens increasing the likelihood of waterborne disease outbreaks and the potential for dangerous microbial *(and perhaps chemical)* exposures to the operators during routine maintenance and cleaning, cartridge filters are not currently recommended. This is not to say that all of the current issues or concerns with cartridge filters could not be resolved.

4.7.2.4.1 Filtration Rates

Cartridge filter elements should have a listed maximum flow rate of 0.375 GPM/ft^2 *(0.26 L/s/m^2)*, but the design filtration rate for surface-type cartridge filter should not exceed 0.30 GPM/ft^2 *(0.20 L/s/m^2)*. Cartridges don't recover 100% capacity when cleaned after fouling. Systems designed to the maximum limit cannot sustain performance *(or minimum POOL TURNOVER requirements)* over time. For example, if a filter only recovers to 80% of the original flux after cleaning, then a filter flow rate of 0.375 GPM/ft^2 *(0.26 L/s/m^2)* would become 0.30 GPM/ft^2 *(0.20 L/s/m^2).* Cartridge replacement would be necessary following fouling levels greater than 20% of the maximum rated capacity.

4.7.2.4.2 Supplied and Sized

The pore size and surface area of replacement cartridges should match the manufacturer's recommendations.

4.7.2.4.3 Spare Cartridge

An extra set of elements, with at least 100% filter area, and appropriate cleaning facilities and equipment should be provided to allow filter cartridges to be thoroughly cleaned. Two sets of filter cartridges should be supplied to allow for immediate replacement and cleaning procedures that involve complete drying of the filter elements.

4.7.3 Disinfection and pH Control

Disinfection and Indoor Air Quality

To provide for a healthy and safe swimming environment in INDOOR AQUATIC FACILITIES, it is important to consider a number of issues that could impact health. Proper ventilation and humidity control are important in removing excess heat, moisture, noxious odors, and harmful DBPs.[156]

Proper Chemical Use

In addition, improper usage of chemicals and inadequate ventilation can also decrease the quality of the indoor air environment and affect health.[27, 29, 30]

High Chloramines

High concentrations of chloramines and other volatile compounds in the air can increase the possibility of health effects such as upper respiratory illnesses and irritation of the mucous membranes including eyes and lungs.[86, 157] Furthermore, these CONTAMINANTS can also cause metal structures and equipment to deteriorate.

Shock Oxidizer

While proper ventilation is critical for INDOOR AQUATIC FACILITIES, water chemistry also can dramatically affect air quality. Concentrations of chloramines and other volatile compounds can be minimized by reducing CONTAMINANTS that lead to their formation *(e.g., urea, creatinine, amino acids, and personal care products)*, as well as by supplemental water treatment. Effective filtration, water replacement, and improved BATHER hygiene can reduce CONTAMINANTS and chloramine formation. Research has shown that the use of non-

CHLORINE shock oxidizers is selective in OXIDATION and might not prevent nor reduce inorganic chloramines though they might reduce some organic chloramines.[158] The EPA final guidelines state that manufacturers of "shock oxidizers" may advertise that their "shock oxidizer" products "remove," "reduce," or "eliminate" organic CONTAMINANTS. Shock dosing with CHLORINE can destroy inorganic chloramines that are formed. SECONDARY TREATMENT such as ozone and UV light might effectively destroy inorganic as well as some organic chloramines.

Swimmer Education

In addition, swimmers should be educated that their behavior *(e.g., urinating in the POOL, failing to SHOWER)* can negatively impact air quality by introducing nitrogen-containing CONTAMINANTS that form volatile compounds.[156]

Reduce and Minimize Impact

These steps can help reduce the chemical role in creating poor indoor air quality and help maintain an environment that minimizes health effects on BATHERS as well as decrease deterioration of AQUATIC FACILITIES and equipment.

4.7.3.2 Feed Equipment

4.7.3.2.1 General

If recirculation pumps stop but chemical feed pumps continue to pump chemicals into the return lines, highly concentrated acid and CHLORINE mix so that eventually when concentrated solutions of CHLORINE and acid are mixed, CHLORINE gas will be formed. The CHLORINE gas could then be released into the AQUATIC VENUE when the recirculation pump is turned on again or in the pump room if there is an opening in the line as has been documented in CDC's Waterborne Disease and Outbreak Surveillance System.[159, 160] To prevent the hazardous release of CHLORINE gas, the chemical feed system shall be designed so that the CHLORINE and pH feed pumps will be deactivated when there is no or low flow in the RECIRCULATION SYSTEM.

4.7.3.2.2 Sizing of Disinfection Equipment

The CMAHC established a Chlorinator Sizing Ad Hoc Committee in 2015 (https://cmahc.org/ad-hoc-committees.php) to address chlorinator sizing by collecting and analyzing actual CHLORINE consumption at operating POOLS since the existing chlorinator sizing requirements were not based on data analysis. Analysis of CHLORINE use data from over 6000 POOLS underscored that existing MAHC dosing requirements are likely excessive in non-SPA AQUATIC VENUES, might be inadequate for SPA operation and, that all AQUATIC VENUES in a given venue type cannot be adequately represented by a single dosing value. In addition, actual CHLORINE consumption at each AQUATIC VENUE appears to be non-linear making it difficult to derive a single dosing rate value. As a result, the Ad Hoc Committee recommended performance-based sizing with consideration of the actual POOL/SPA CHLORINE demand factors such as BATHER load, exposure to vegetation and airborne debris, aeration, volume, water temperature, sunlight *(UV)*, and CYA. This performance-based language places the burden on the DESIGN PROFESSIONALS and equipment suppliers to properly size dosing equipment. Further data collection and analyses are needed to better understand if CHLORINE use can be more accurately modeled to make chlorinator sizing more data based.

4.7.3.2.5 Types of Feeders

All UV units shall be installed into the system by means of a bypass pipe to allow maintenance on the UV unit while the AQUATIC VENUE is in operation.

4.7.3.2.7 Feeders for pH Adjustment

It is recommended that the solution's reservoir supply be sized to hold a minimum of 1 week's supply.

4.7.3.2.8 Automated Controllers

Constant and regular MONITORING of key water quality parameters such as the DISINFECTANT concentration and pH are critical to prevent recreational water illness and outbreaks. AUTOMATED CONTROLLERS are more reliable as a MONITORING device than personnel and hand feeding chemical. Automated chemical controllers are therefore required for use on every AQUATIC VENUE with a time of 1 year built in for facilities to become

compliant after adoption of this requirement. The use of AUTOMATED CONTROLLERS does not negate the requirements for regular water testing. Automated units require verification of proper function and the probes do fail or slip out of calibration. This can only be detected by MONITORING the water quality.

4.7.3.3 Secondary Treatment

4.7.3.3.1 General Requirements

4.7.3.3.1.1 ANSI Listing and Labeling

EPA regulates the labeling of pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act *(https://www.epa.gov/laws-regulations/summary-federal-insecticide-fungicide-and-rodenticide-act accessed May 10, 2024)*. According to EPA requirement 40 CFR 156.10, the establishment registration number may appear in any suitable location on the pesticide label or immediate container. More information on pesticide establishment registration numbers can be found at https://www.epa.gov/pesticide-registration/pesticide-registration-manual-chapter-13-devices *(accessed May 10, 2024)*.

4.7.3.3.1.2 Required Facilities

Due to the risk of outbreaks of RWIs associated with the DISINFECTANT tolerant parasite *Cryptosporidium*, it is strongly recommended that all AQUATIC FACILITIES include SECONDARY TREATMENT to minimize the risk to the public associated with these outbreaks.

Increased Risk Aquatic Venues

However, there are some AQUATIC VENUES where the risk of acquiring a RWI is elevated *(INCREASED RISK AQUATIC VENUES)* due to either the use of the AQUATIC VENUE, or the users. THERAPY POOLS, for example, are often utilized by individuals with compromised immune systems or open wounds. The risk of acquiring an RWI is substantially increased under such circumstances. WADING POOLS are utilized by small children who may be in diapers. Incontinent infants and small children are likely to increase the contamination burden *(e.g., urine and feces)* in the water, thereby creating an increased risk of disease to other users. In addition, cryptosporidiosis is more prevalent in younger children.[118] Interactive water play venues such as spray pads, fountains, and similar features are most often used by smaller children who are likely to increase the risk of water contamination occurring. They also might be more likely to suffer from more severe illness when they become infected.

Intent

The intent of requiring a SECONDARY TREATMENT is to limit the length of time of exposure to agents that cause diarrheal illness, in particular *Cryptosporidium*, after a fecal release in INCREASED RISK AQUATIC VENUES.

Facilities

These facilities include THERAPY POOLS, and WADING POOLS, water ACTIVITY POOLS, INTERACTIVE WATER PLAY AQUATIC VENUES *(e.g., spray pads)*, and other AQUATIC VENUES with no standing water designed primarily for young children, including children less than 5 years of age. In these facilities, the potential of diarrheal illness is elevated due to the population mix of the BATHERS and the design of the facility. The pathogens of concern in such facilities are *Cryptosporidium*, *Giardia*, *Shigella*, *E. coli* O157:H7, and norovirus. *Shigella* and *E coli* 0157:H7 are very sensitive to traditional CHLORINE DISINFECTION. However, the seriousness of illness caused by highly (*Cryptosporidium*) and moderately (*Giardia*, norovirus) CHLORINE tolerant pathogens is the reason a SECONDARY TREATMENT is required for all new or substantially altered construction of these types of AQUATIC FACILITIES after the adoption of this CODE. When older facilities are substantially altered, they must retrofit to meet this treatment requirement.

4.7.3.3.2 Log Inactivation and Oocyst Reduction

4.7.3.3.2.1 Log Inactivation

Examples of SECONDARY TREATMENT include but are not necessarily limited to UV DISINFECTION and ozone DISINFECTION. Due to circulation hydraulics, there is no significant advantage to having 3-log inactivation instead of 2-log inactivation. Allowing either 2-log or 3-log inactivation per pass, as specified, will provide more flexibility to POOL operators in choosing systems *(e.g., filtration, ozonation, or UV)* that will still

provide a 3-log reduction of *Cryptosporidium* in the POOL within seven TURNOVERS. Using Gage-Bidwell's law of dilution, MAHC Table 4.7.3.3.2.1 shows the log reduction of *Cryptosporidium* in the POOL vs. the number of TURNOVERS for SECONDARY TREATMENT that provide 2-log and 3-log reductions per pass through the SECONDARY TREATMENT.

Table 4.7.3.3.2.1 Turnovers Required to Achieve 2-log and 3-log Removal of *Cryptosporidium* in Pools

Turnover	Log removal in pool with 2-log SECONDARY TREATMENT	Log removal in pool with 3-log SECONDARY TREATMENT
0	0.00	0.00
1	0.43	0.43
2	0.86	0.87
3	1.29	1.30
4	1.72	1.74
5b	2.15	2.17
6	2.58	2.60
7	3.01	3.04

The table clearly shows that the 2-log secondary system and 3-log secondary systems provide virtually the same log reductions in the POOL. Both can provide a 3-log reduction of crypto in the POOL after 7 TURNOVERS. The values in the table were calculated using the following equation:

Log removal in the POOL = Log (e (efficiency x TURNOVER)) where the efficiency of a 3-log reduction system is 0.999 and the efficiency of a 2-log system is 0.99. For example, with a 2-log secondary system and one TURNOVER, log removal in the POOL = Log (e (0.99 x 1)) = 0.43.

Allowing a combination of treatment systems for Cryptosporidium oocyst reduction is also a staple of the EPA for drinking water treatment, where utilities or engineers can assemble multiple systems to meet Cryptosporidium reduction goals. This system is often referred to as the "Microbial Toolbox." (shown on page 14).(161)

Removing 1-log (or 90%) of 1,000 Cryptosporidium oocysts would mean reducing the total number to 100 oocysts. A second 1-log (90%) reduction of the 100 oocysts remaining would leave 10 oocysts. A third 1-log (90%) reduction of the 10 oocysts remaining would leave 1 oocyst. Totaling up the 3 1-log reductions you get a 3-log reduction (since a 3-log [99.9%] reduction of 1,000 oocysts also leaves 1 oocyst). You cannot add 90% + 90% + 90% to get 270%, but you can add 1-log + 1-log + 1-log to get 3-log.

One more advantage of combining 2 or more treatment processes is that they can work together to prevent situations where any one process alone might fail. For example, a 3-log UV system might fail to inactivate *Cryptosporidium* OOCYSTS if the UVT of the water gets too low. Whereas a system that puts a 1-log filter in front of a 1-log ozone system and in front of a 1-log UV system could filter out the particles that might impair the ozone or UV system, ozonate the organics that might impair the UV system, and allow the UV system to work efficiently at all times.

4.7.3.3.2.2 Installation

SECONDARY TREATMENT is 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. For INTERACTIVE WATER PLAY AQUATIC VENUES, the SECONDARY TREATMENT is to be located after the feature pump to treat 100% of the water prior to reaching the PATRONS. The filtration system operates continuously, which is necessary to achieve the intended reduction of *Cryptosporidium* in the treatment tank in the specified time period. Installation on an AQUATIC FEATURE loop will not ensure that the intended treatment outcome will be

met, especially since the feature pumps do not typically operate continuously throughout the entire day *(24 hours; typically turned off at night)*.

4.7.3.3.2.4 Minimum Flow Rate Calculation

The SECONDARY TREATMENT is to be designed to reduce an assumed total number of infective *Cryptosporidium* OOCYSTS in the total volume of the AQUATIC VENUE from an assumed 100 million *(10^8)* OOCYSTS to a maximum concentration of one infective OOCYST/100 mL by means of consecutive dilution.

4.7.3.3.2.5 Equation

In considering the potential for outbreaks, it was decided that a treatment system should be designed to limit the outbreak to a reasonable period of time, preferably to a single day of operation. This means that all pathogens of concern that might still be present at infective concentrations at the close of operations are reduced to below a level of infectivity by the opening time of the following day. This approach has been recommended because numerous multi-day outbreaks have been well documented.[162-164] To design a treatment system that can reduce the duration of exposure to a single day, the MAHC Committee made the following assumptions:

- The target of concern is *Cryptosporidium*. Based on known CT INACTIVATION VALUES, all other pathogens will be inactivated within an hour if the facility is maintaining at least 1 ppm of free CHLORINE.
- At a concentration of 1 ppm free CHLORINE, any *Cryptosporidium* OOCYSTS left circulating in the water might be infective for up to 15,300 minutes *(>10 days)* after introduction.
- A single contamination event *(e.g. diarrheal incident)* of ~100 mL could introduce 108 *Cryptosporidium* OOCYSTS into the water.[111, 112]
- Reducing the amount of *Cryptosporidium* below the level at which there is one infectious OOCYST per average volume swallowed by swimmers *(16-128 mL)* would be a reasonable target for overnight remediation of the water to reduce the risk of transmission beyond the day of initial contamination.[165-167] The concentration chosen was one OOCYST/100mL.
- The only effective means currently to reduce the concentration of OOCYST in an AQUATIC VENUE while open for bathing is by dilution *(this does not include HYPERCHLORINATION, which requires closure of the water to BATHERS)*. Accomplishing dilution through the introduction of sufficient makeup water is not practical. Instead, the solution is to remove a portion of the water, treat it to reduce the concentration of infectious OOCYSTS, and then return that water to the AQUATIC VENUE.
- SECONDARY TREATMENT can practically achieve a 3-log *(99.9%)* reduction in the number of infective OOCYSTS per pass through the SECONDARY TREATMENT.
- Due to imperfect mixing and other real work constraints, a SAFETY factor of 1.33 has been applied to the maximum dilution time, defined as the time it will take for 108 OOCYSTS introduced into an AQUATIC VENUE *(e.g., a diarrheal event)* to be reduced to a maximum concentration of one OOCYST per 100 mL. A reasonable expected overnight closure time for an AQUATIC VENUE is 12 hours *(e.g., 8 p.m. to 8 a.m.)*. Therefore 9 hours has been established as the maximum dilution time *(12 / 1.33 or 12 x 0.75)* to be used when sizing a SECONDARY TREATMENT. If the actual expected closure time of a venue is less than 12 hours, then 75% of that value shall be used for the dilution time.
- Following is the derivation of the equation for Q found in MAHC 4.7.3.3.2.5.

  C = needed resulting concentration after a given time period = 1 OOCYST per 100 ml (37.85 OOCYSTS per 1 gallon)

  C_0 = initial concentration = 10^8 OOCYSTS / V

  r = efficiency = 0.999 for 3-log reduction per pass, or 0.99 for 2-log reduction per pass

  t = time (minutes)

  V = volume (gallons)

  Q = flow rate (GPM)

  T = number of TURNOVERS = Qt/V

e = Euler's mathematical constant whose value is approximately 2.71828.

$C = C_0 * e^{-rT}$

$C/C_0 = e^{-r(Qt/V)}$

$\ln C/C_0 = -r(Qt/V)$

$\ln C - \ln C_0 = -rt(Q/V)$

multiply both sides by -1/rt

$(\ln C - \ln C_0)/-rt = Q/V$

$(\ln C_0 - \ln C)/rt = Q/V$

$Q = V [(\ln C_0 - \ln C)/rt]$

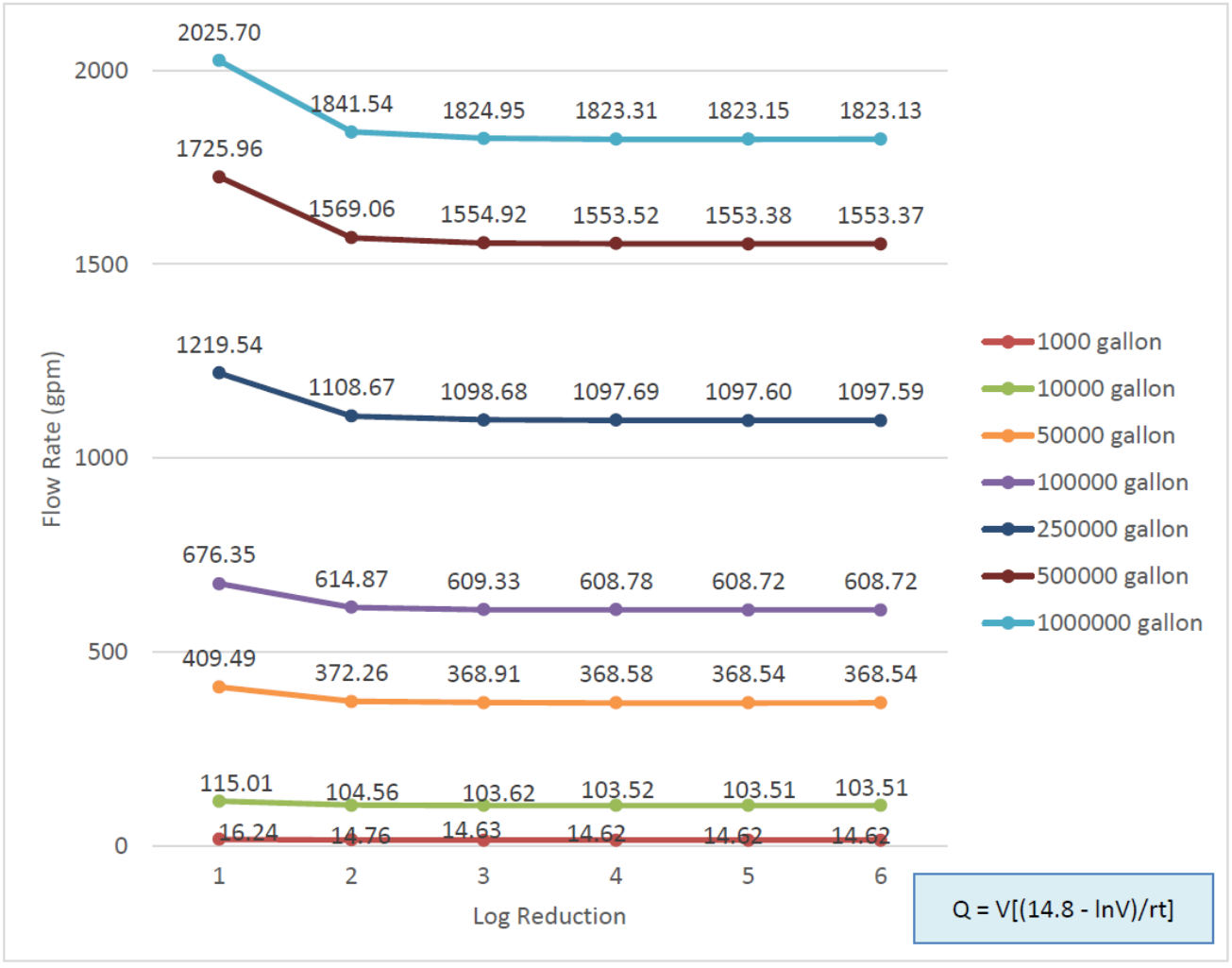
$Q = V\{[\ln(10^8/V) - \ln 37.85]/rt\}$

$Q = V [(18.42 - \ln V - 3.63)/rt]$

$Q = V [(14.79 - \ln V)/rt]$

- If a 9-hour (540 minute) dilution time is assumed, this equation can be used to calculate the data displayed in the following graph.

Figure 4.7.3.3.2.5: Flow Rate per Volume for a Given Log Reduction, 9-hour Dilution Time



Any treatment system that demonstrates this reduction in *Cryptosporidium* OOCYSTS specified herein is suitable for use. It is not the intent of the MAHC to limit technology only to UV and ozone as discussed in the CODE, but rather to specify the outcome of the treatment.

Purpose

The purpose of SECONDARY TREATMENT is to reduce the viable *Cryptosporidium* OOCYSTS to a number below that which is considered an infective dose *(number/volume swallowed)*, should the parasite be introduced into an AQUATIC VENUE. While 100% UV treatment of recirculated water is an option, it is important to note that this will not ensure the SAFETY of the BATHERS immediately following a fecal event, but it will reduce the time required for the system to get below an infective dose. While this is beneficial, mandating UV on 100% of the recirculated water flow might lead owners and designers to minimize the total recirculated flow to not incur the additional capital and operating cost of the required additional UV, ozone, or other SECONDARY TREATMENT. *Cryptosporidium* control is not the only consideration when designing an INCREASED RISK AQUATIC VENUE, and it is important that this requirement does not negatively influence other design considerations—such as amount of filtration needed for particulate removal and control of turbidity. Consideration was therefore given to what should be the maximum time a system takes to reduce the viable OOCYST concentration to below an effective dose. Because a fecal event can release 100 million OOCYSTS and an infective dose is as little as one OOCYST per 100 mL, it is not possible with available technology to ensure the SAFETY of BATHERS in the AQUATIC VENUE both at the time the fecal event occurs and in the immediate aftermath. A reasonable and logical maximum time for reducing the OOCYST concentration to below one OOCYST/100mL was determined to be the lesser of 9 hours or 75% of the time an AQUATIC VENUE is closed in a 24-hour period. The goal of this is to ensure an AQUATIC VENUE is free of viable *Cryptosporidium* OOCYSTS, or at least have the number below an infective concentration every day the AQUATIC VENUE opens to the public.

Example of Equation

The actual calculation used to determine the amount of needed SECONDARY TREATMENT is based upon the understanding that the treatment of recirculated AQUATIC VENUES involves serial dilution, whether we are talking about particulate removal or rendering *Cryptosporidium* OOCYST ineffective. Assuming an initial concentration of 108 OOCYSTS, recognizing the limit of an infective dose is one OOCYST/100 mL, and allowing for a 99.9% reduction in infective OOCYST by the SECONDARY TREATMENT, it can be derived that needed flow through the SECONDARY TREATMENT is as given in the MAHC.

An example of how to calculate for the needed flow is as follows:

$Q = V \times \{[14.8 - \ln(V)] / (60 \times T)\}$, where:

- Q = SECONDARY TREATMENT 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.)*
- For a 100,000-gallon *(378,541 L)* AQUATIC VENUE which is closed 12 continuous hours out of every 24 hours, 75% of which is 9 hours:
- $100{,}000 \times \{[14.8 - \ln(100{,}000)] / (60 \times 9)\} = 609$ GPM

Therefore, the 100,000-gallon *(378,541 L)* AQUATIC VENUE would require a SECONDARY TREATMENT which has a flow rate of at least 609 GPM. If this AQUATIC VENUE is designed with a 2-hour filtration TURNOVER RATE, the flow through the filters would be 833 GPM. An owner or designer can choose to size the secondary filtration system to be 609 GPM, 833 GPM, or anything in between. If the owner or designer chooses to size the SECONDARY TREATMENT equal to the filtration flow rate *(833 GPM)* the time it would take to reduce 108 OOCYSTS to 1 OOCYST/100 mL would be 6.6 instead of 9 hours.

4.7.3.3.2.7 Flow Rate Measurements

Consideration was given for simplifying the sizing of the SECONDARY TREATMENT and having the flow rate through the SECONDARY TREATMENT equal to the overall treatment system flow rate. While this was initially recommended by the MAHC, ultimately this approach was rejected. A basic premise of the MAHC is to

establish performance-based STANDARDS supported by data and science whenever possible. Sizing the SECONDARY TREATMENT equal to the overall treatment system flow rate, while simplifying the design and operation of the facility, does not meet any defined criteria for reducing or eliminating risk to the BATHERS using the AQUATIC VENUE. It was felt that establishing specific criteria for sizing the SECONDARY TREATMENT independent of the criteria for sizing other treatment system processes *(e.g., filtration flow rate)* was the approach most likely to protect the public's health.

Maximum Concentrations

In developing this approach, the MAHC considered establishing maximum permissible concentrations of OOCYSTS, which would be MONITORED and verified, but the MAHC rejected that approach as impractical since this would require actual laboratory testing. Establishing a concentration-based STANDARD for the water cannot readily be implemented because:

- There is no practical method to rapidly determine the number of OOCYSTS in the water and thus no method to enforce the STANDARD.
- There are multiple and interrelated biological variables in exposure estimations. These include the number of OOCYSTS released per fecal incident, the number of incidents per day, strain differences in pathogenicity, the amount of water swallowed, and differences in individual susceptibility.
- The circulatory patterns in facilities are complex and unique to each AQUATIC FACILITY.

Requiring that the SECONDARY TREATMENT deliver a treatment that ensured the OOCYST concentration was reduced to a specified level would require multiple biological assumptions and computer modeling that exceed those currently required for any other water parameter.

4.7.3.3.3 Ultraviolet Light Systems

UV DISINFECTION is a SECONDARY TREATMENT and must meet the minimum requirements of all SECONDARY TREATMENT as defined in MAHC 4.7.3.3. The minimum requirements must be read in conjunction with the clarifications and additional information as detailed below.

Mercury clean-up procedures for broken UV lamps can be found in Section E.1.2 of EPA 815-R-06-007 Appendix E: https://www.epa.gov/system/files/documents/2022-10/ultraviolet-disinfection-guidance-manual-2006.pdf. The MAHC agrees that knowledge of appropriate mercury clean-up is essential for operator SAFETY. If this is considered for inclusion in the MAHC then additional guidance on training requirements should be included. Guidance should include who should be trained *(e.g., owner, operator, manager)*, the type of training required *(e.g., on the job, classwork)*, and how inspectors should verify operators are trained *(e.g., completion certificate, demonstration of knowledge)*. Such guidance can be found in Section E.1.2 of EPA 815-R-06-007 Appendix E.

4.7.3.3.3.1 Third Party Validation

Validation to a recognized national STANDARD is carried out by a recognized and capable third party. Such validation needs to take into consideration lamp life, UV MONITORING, and optical water quality. Typical POOL water qualities vary, but a design UV TRANSMISSIVITY assumption of better than 94% T10 should not be used. T10 is the ability of an object to transmit UV. Where possible, transmissivity tests should be obtained for existing facilities.

4.7.3.3.3.1.1 Validation Standard

Validation is a process by which any UV unit is tested against a surrogate microorganism to determine its performance. Validation is required because there is no online test of a UV unit's ability to DISINFECT and, due to the relatively short contact time, it is impossible to size units accurately based on just calculations. It is important to note that evidence of testing is not the same as validation. Validation must adhere to the following criteria:

- Follow one of the approved validation systems, preferably the EPA 815-R-06-007,
- Have been carried out be a genuine third party, and
- Include all the required validation factors and RED bias.

The validated performance is based on the flow and transmissivity of the water to be treated. Therefore, it is essential that the system is used within its validated performance range. A system operated outside its validated range is NOT acceptable.

Validation Factor

The validation factor is used to account for statistical variations in the recorded data during third party testing. The validation factor is required to ensure that the equipment's actual performance will always be equal to or better than its validated performance. This figure can be between 15–35% depending on the quality of the testing and must be included in any validated performance curve.

Transmissivity (Transmission)

The transmissivity *(often called transmission)* of the water to be treated is an important design factor in sizing a UV system. The transmissivity is normally quoted as a % value in either a 1 cm, 4 cm, or 5 cm cell. It is measured in a UV Spectrophotometer. In many water treatment applications, this value will vary considerably but AQUATIC VENUES are for the most part consistent, due to the bleaching effect of the CHLORINE used as a residual DISINFECTANT. Typically, AQUATIC VENUES will have a transmission of 94–95% in a 1 cm cell, with interactive water play venues 92–94%. The installation of a UV unit itself will increase the transmission by perhaps 2% due to the improvement in the POOL water quality so the values noted above refer to a situation where a UV unit is installed and operational. Design transmissions over 94% are not recommended, and exceptionally heavily loaded AQUATIC VENUES might consider using a lower number as a design basis. It is also important to understand that as transmission is reduced, the performance of the equipment is reduced and the RED bias increases, requiring the UV to deliver more performance. For this reason, the performance difference between any equipment's validated performance at 98% transmissivity and actual field performance at 94% transmissivity can be 40% lower. When presented with validated performance data at 98% transmission, operators should therefore be aware that the equipment might only deliver half the performance when installed.

Validation Range

A validated system will have different performance levels at different water qualities and flows. The relationship between these is traditionally represented as a performance curve where the performance can be noted at any point on this curve. However, the lowest transmission test point and the highest flow tested are normally considered the extents of the validated range. This means that any UV unit tested at 95% and above is NOT validated at transmissions lower than 95%. For the same reason, a unit tested at a maximum flow of 500 GPM is NOT validated for any flow over 500 GPM. Validation factors can reduce equipment validated performance by 30%, so it is essential that systems without validation factors built into performance curves are not considered validated. The performance of a UV system in the field is measured by a combination of flow and intensity readings from the UV sensors. Performance in the field can be verified on inspection by regulators who will compare actual sensor readings with those indicated on the performance charts, so these charts must be retained at the AQUATIC FACILITY for each validated system. UV equipment is utilized for its ability to DISINFECT CHLORINE-tolerant pathogens and for its ability to reduce COMBINED CHLORINES in the POOL water. For the latter, typically a calculated dose of 60mJ/cm^2 is utilized based on the total UV-C and UV-B spectrum. This is similar to the validated dose requirements of the SECONDARY TREATMENT. Where UV is fitted as a supplemental treatment system the CODE allows some operational and equipment concessions. Operators should note that the regulations as stated represent BEST PRACTICE; but where specific circumstances dictate, then the equipment specifications may be reduced. For a supplemental treatment system, the operator may consider reducing the dose applied to the process. This will reduce performance accordingly, and operators should carefully consider such reduction in performance and ensure that the equipment will still provide a beneficial level of performance.

4.7.3.3.3.4.1 Alarm/Interlock Setpoint

This requirement is intended to ensure that UV sensor placement is considered when determining the minimum setpoint to alarm/interlock. UV equipment validated through the UV Intensity Setpoint Approach relies on UV intensity readings by UV sensors to account for changes in UV transmittance *(UVT)*, and therefore UVT is not MONITORED separately during operations to confirm dose delivery. However, proper

positioning of sensors is necessary to accurately relate a given UV intensity to a specific level of dose delivery, irrespective of changes in UVT or lamp output. Refer to EPA 815-R-06-007 Chapter 3 Section 3.5.2.1 and Appendix D Section D.2 for a discussion of the importance of ideal placement of sensors and the impact of sensor positioning on UV dose MONITORING. This requirement is not intended to specify sensor placement, which is addressed in the validation process. However, if a UV sensor is not placed as close as possible to the "ideal" location *(i.e., positioned so that the UV intensity reading is proportional to the UV dose, irrespective of changes in UVT and lamp output)*, it is necessary to adjust the alarm/interlock setpoint accordingly. This adjustment should account for the disproportionate impact of changes in UVT or lamp output on the measured intensity as a result of sensor positioning to ensure that the minimum dose is delivered at the specified flow rate. EPA 815-R-06-007 Appendix D. Section D.2.1 items 1–3 and their respective examples *(D.2, D.3, and D.4)* and figures *(D.5 (a), (b) and (c))* provide a detailed discussion of the impact of UV sensor positioning on the relationship between UV dose and intensity readings.

4.7.3.3.3.9 Minimum RED

The EPA identifies the required dose for various organisms to achieve 3- or 4-log reduction. This dose must be modified by the RED bias to ensure delivery of validated performance. Depending on the quality of the water, this RED bias can be 35–70%.

4.7.3.3.4 Ozone Disinfection

4.7.3.3.4.1 Log Inactivation

Ozone is a SECONDARY TREATMENT and must meet the minimum requirements of all SECONDARY TREATMENT as defined in MAHC 4.7.3.3. Ozone is an antimicrobial oxidizer. Its use as a SECONDARY TREATMENT in commercial swimming POOLS in the United States dates back to the 1930s. Ozone is proven to kill *Cryptosporidium*[168], *Giardia*[169], *E. coli*[170], and *Pseudomonas aeruginosa*[171], along with any other microorganism potentially found in AQUATIC VENUES, and is a strong oxidizer. Exposure to ozone gas can result in irritation to the eyes and respiratory tract if not generated and handled correctly. Therefore, OSHA has identified a time weighted average *(TWA)* of 0.1 ppm *(0.1 mg/L)* as the permissible exposure limit (PEL) for ozone.

4.7.3.3.4.2 Onsite Measurement

Validation is a process by which any ozone unit is tested against a surrogate microorganism to determine its performance. Validation is required because there is no online test of an ozone unit's ability to DISINFECT and, due to the relatively short contact time, it is impossible to size units accurately based on just calculations. It is important to note that evidence of testing is not the same as validation. NSF/ANSI Standard 50 now includes the ozone/*Cryptosporidium* validation STANDARD; it is no longer in an Annex but is now a portion of the ozone section in the whole STANDARD that was published in 2013.

4.7.3.3.4.3 Suitable for Use

All materials must be ozone resistant. The strong oxidizing power of ozone shall be considered when choosing materials for pipes, valves, gaskets, pump diaphragms, and sealant. Materials for water piping, tanks, and other conveyance shall be nearly inert. 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.

Suitable materials and their uses are:

1. Ozone/Air or Ozone/Oxygen:

- Concentrations above 2,500 ppm *(mg/L) (0.4 % wt)*
  - PTFE, FEP *(Teflon®)* – tubing, O-rings, or ozone cell materials
  - PVDF *(Polyvinylidene Fluoride)*, Kynar® *(Pennwalt patent)* – tubing, injection, check valves
  - Stainless Steel, grade 316L – tubing or ozone cell materials
  - Glass and most ceramics – ozone cell materials
  - Aflas® – seals, O-rings, gaskets
- Concentrations below 2,500 *(in addition to those above)*

- Viton® – tubing, seals, O-rings
- Kel-F® – seals & O-rings

NOTE: *Stainless steel tubing shall only be used when the feed-gas is dried to a dew point below -76 °F (-60° C), and where no chance of water ingress exists. CORROSIVE acids formed in moist air will corrode the pipes from the inside.*

2. Dissolved Ozone in Water (in addition to all those listed above):

- PVC or CPVC *(schedule 40 or 80)*
- EPDM *(Ethylene - propylene terpolymer)*
- PVDF *(Polyvinylidene Fluoride)*, Kynar® *(Pennwalt patent)*

3. Gaskets and O-rings

Aflas®, Kalrez®, and Teflon® are acceptable gasket materials for both gas and aqueous seals.

Viton®, EPDM, and "Red Silicon" do not provide sufficient resistance to deterioration at ozone concentrations above 1.5% *(gaseous)* but work well in aqueous ozone solutions. If used for gaseous application, these shall only be used in static seals and replaced regularly.

4. Joint Sealing

Properly applied Teflon tape may be used successfully for sealing joints; however, threaded fittings shall be avoided where possible. Hypalon® and silicone sealers which do not contain rubber filler are also successful.

4.7.3.3.4.7 Installation and Injection Point

4.7.3.3.4.7.2 Gas Monitor / Controller

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.

4.7.3.4 Supplemental Treatment Systems

4.7.3.4.1 General Requirements

4.7.3.4.1.1 Optional

AQUATIC VENUES that do not require SECONDARY TREATMENT have the option to utilize SUPPLEMENTAL TREATMENT SYSTEMS. These systems might not afford DISINFECTION protection against *Cryptosporidium* and might not remove chloramines as effectively as SECONDARY TREATMENT. However, if sized within supplementary treatment system requirements in MAHC 4.7.3.4, a supplemental treatment system may be of benefit in maintaining air quality at indoor facilities, reducing the *Cryptosporidium* burden over an extended period of time, and reducing the amount of DISINFECTANT needed to maintain required DISINFECTANT concentrations. Although supplementary treatment systems are optional, it should be noted that this CODE, as written, represents BEST PRACTICE.

4.7.3.4.2 Ultraviolet Light

Refer to information presented in MAHC Annex 4.7.3.3.3.

4.7.3.4.3 Ozone

Refer to information presented in MAHC Annex 4.7.3.3.4.

4.7.3.4.4 Copper / Silver Ion System

The scientific data available on efficacy of these systems is predominantly for bacterial inactivation and usually includes FAC.[172, 173] There is limited scientific literature that documents the efficacy of these systems on viruses and parasites. Given the importance and frequency of RWIs associated with these other microorganisms *(viruses and parasites)*, it is essential that DISINFECTION chemicals / systems are also effective against such microorganisms as well.

4.7.3.4.5 Ultraviolet Light / Hydrogen Peroxide Systems

UV/peroxide systems have not been registered by the EPA as primary DISINFECTANT systems for recreational water. Although UV is a DISINFECTANT, it does not impart a persistent residual disinfecting property to water. To overcome this, UV/peroxide systems claim, or in some cases, imply that the inclusion of hydrogen peroxide in the system supplies a DISINFECTANT in the bulk water in the AQUATIC VENUE. Hydrogen peroxide is used as a hard surface DISINFECTANT and has been granted registration for this purpose by the EPA. When used as a hard surface DISINFECTANT, hydrogen peroxide is normally used at around 3%. When used in recreational water, hydrogen peroxide is used at 27 to 100 ppm *(mg/L)*, which is 1111 and 300 times, respectively, more dilute than that used on hard surfaces. At these low concentrations, hydrogen peroxide is not an effective DISINFECTANT. Thus, UV/peroxide systems do not provide a persistent DISINFECTANT in the bulk of the water in the AQUATIC VENUE. Further, hydrogen peroxide is not registered by the EPA for use as a DISINFECTANT in recreational water. Since it is not EPA REGISTERED, the use of hydrogen peroxide as a DISINFECTANT, or any market claims that implies hydrogen peroxide provides any biological control, is a violation of FIFRA. UV/peroxide system should not be used as a supplemental treatment system on CHLORINE treated AQUATIC VENUES. The addition of hydrogen peroxide to a CHLORINE-treated POOL will inactivate the HOCl. If sufficient hydrogen peroxide is added, the HOCl will be completely eliminated and no DISINFECTANT for inactivation of pathogenic organisms will remain.

4.7.3.5 Water Quality Testing Devices and Kits

WQTDs should be stored as specified by the manufacturer's instructions. Failure to properly store WQTDs will result in incorrect readings. NSF/ANSI 50 for WQTDs in 2013 currently contains specified precision and accuracy requirements for measuring pH, free and total CHLORINE, and free and TOTAL BROMINE. There are three levels of accuracy and precision deemed level 1, 2 and 3, with the highest accuracy and precision in level 1 devices. The test water specifications include alkalinity, calcium hardness, and TDS. It is important for a QUALIFIED OPERATOR to use equipment that is easy to read and as objective as possible. The current, common means of testing AQUATIC VENUE water using colorimetric test kits is subjective because the color and intensity must be compared. Titration testing for free and COMBINED CHLORINE is an objective test, which is accurate to 0.2 mg/L with an easily recognizable start and end point. Therefore, titration testing is recommended over colorimetric testing. Due to the use of inconsistent concentration gradations *(i.e., the difference in concentration between adjacent color blocks)* and the subsequent rapid darkening of the color blocks *(e.g., above 1.5 mg/L)*, the accuracy of colorimetric test methods is likely to be lower than for titration test methods. Visual colorimetric methods are accurate only to +/- half the difference between the adjacent color blocks, and thus the confidence limits for these methods are wider at higher concentrations *(e.g., above 1.5 mg/L)*. Where portable colorimeter test kits are affordable, these are the most accurate kits available for use at poolside. Most water tests involve color development. Interferences in the water can cause them to produce a different color, produce the wrong color intensity, or be unable to produce the expected color. When sample water is below 60º F *(16° C)* it should be gently warmed to at least 60º F *(16° C)* to ensure accurate results. Color matching tests for CHLORINE/bromine provide accuracy equal to approximately half the difference between known values of the color STANDARDS. As the CHLORINE/bromine concentration rises, the greater the difference will be between the known color STANDARDS. Thus, the readings become subjective as the difference increases. The following MAHC Table 4.7.3.5 summarizes some common interferences and how they impact the test color in DISINFECTANT tests.

Table 4.7.3.5: Water Tests and Interference

Test	Interference—High Chlorine	Interference—Metals: Cu, Fe, Mn	Interference—High Calcium	Interference—Monopersulfate
Chlorine	At approximately 10 ppm, might cause partial or total bleaching of the DPD reagents, resulting in lower pink color intensity, or no pink color at all.	None	May cause the sample to turn cloudy white when adding DPD #1.	Will cause a false positive (more intense pink color) for combined chlorine at any concentration and for free chlorine at high concentrations (over 25 ppm).
pH	Might create a different indicator, chlorophenol red, that is purple at pH 6.6 and higher.	None	None	None

Test	Interference—High Chlorine	Interference—Metals: Cu, Fe, Mn	Interference—High Calcium	Interference—Monopersulfate
Total Alkalinity	Might cause the beginning color to be light blue and the endpoint to be yellow, rather than the expected starting green color and red (pink) endpoint.	None	None	None
Calcium Hardness	None	Expected blue color never fully develops, and the endpoint approaches blue, but fades to a light purple.	None	None

High Chlorine Effects on Chlorine Testing:

If the water sample indicates high CHLORINE concentrations, usually over 10 ppm *(10 mg/L)*, the DPD reagents may partially or totally bleach out, resulting in a false low or zero CHLORINE reading. The addition of double the quantity of DPD reagent during testing might minimize this interference or the analyst can use a smaller sample size or dilute the sample with distilled or deionized water *(DI)* water. Reference the WQTD's use instructions to guard against false readings and interferences.

High Chlorine Effects on pH Testing:

If the CHLORINE reading is high, the tester must wait until it is lowered to a normal concentration before retesting the pH, to ensure an accurate reading. Some analysts neutralize the DISINFECTANT first by adding a drop of CHLORINE neutralizer *(i.e., sodium thiosulfate)*. This is not recommended since the reaction between thiosulfate and CHLORINE can change the pH of the sample and give an inaccurate reading.

High Chlorine Effects on Total Alkalinity Testing:

High CHLORINE will affect the Total Alkalinity reading. Some reagents will bleach out and the color change will be from blue to yellow instead of the expected green to red/pink. Refer to the WQTD's instruction manual to prevent false readings and interferences.

Metals:

Be sure to identify the source of the metal to address the problem. Likely sources are copper from algaecides or corroded pipes, or iron and manganese from the fill water.

Effect of Metals on Calcium Testing:

For the calcium test, copper, iron, and manganese dissolved in the water might prevent the expected blue color *(indicating the end of the test)* from fully developing. As the end of the test approaches blue, it fades to a light purple instead, which results from the metals in the water. Repeat the test, but before proceeding with the test instructions, add 5 or 6 drops of titrant. Remember to add the 5 or 6 drops to your final drop count when finished to determine the calcium concentration.

High Calcium Effects on Chlorine Testing:

When high calcium concentrations are in the water, the sample might turn cloudy with the addition of DPD #1 liquid reagent, which is alkaline. Addition of DPD #2 liquid reagent might not clear up the cloudiness. With high calcium water, adding DPD #2 prior to adding DPD #1 will acidify the sample, turning it slightly pink, and the cloudiness will not appear. Add DPD #1 to complete the test and obtain the proper pink color for the amount of CHLORINE in the water.

Potassium Monopersulfate Shock:

Potassium monopersulfate produces a false high COMBINED CHLORINE reading whenever it is present in the water. Monopersulfate will also produce a false positive free residual CHLORINE reading when the monopersulfate concentration is high *(over 25 ppm)*. Monopersulfate interference can be removed by a variety

of products found in the marketplace. Refer to the WQTD's instruction manual to prevent false readings and interferences.

4.7.3.6 Microbiological Testing Equipment

Microbiological testing equipment and methods should be EPA REGISTERED, conforming STANDARD Methods for the Examination of Water and Wastewater, 23rd Edition, 2017[174] existing professional guidelines, or other recognized international guidelines or STANDARDS. At this time, routine microbiological testing for POOLS, SPAS, and other AQUATIC VENUES is not recommended in the MAHC. Routine MONITORING of chemical concentrations *(e.g., of DISINFECTANT)* and proper operation and maintenance of the AQUATIC VENUE have historically been sufficient to ensure that proper BARRIERS are maintained to minimize potential infectious disease risks from CHLORINE sensitive pathogens. Currently, routine MONITORING for CHLORINE-tolerant microorganisms (e.g., *Cryptosporidium* spp.) is not a feasible or cost-effective disease prevention approach. Chemical tests such as free residual CHLORINE, pH, CT INACTIVATION VALUES, and others provide a good indication of operational control of an AQUATIC VENUE. However, while these tests provide an indication of DISINFECTION potential, they might not provide complete assurance of the microbial quality of AQUATIC VENUE water. While agencies such as the World Health Organization[56], the South Australia Environmental and Public Health Service[175], and the United Kingdom Health Protection Agency[176] have established STANDARDS for routine MONITORING of public and semi-public AQUATIC VENUES for microbial parameters including enteric bacteria (fecal organisms or *E. coli*), *Pseudomonas aeruginosa*, and *Legionella*, there is insufficient scientific data for the purposes of the MAHC to indicate that these routine MONITORING STANDARDS provide an increased level of public health protection beyond adherence to current BEST PRACTICES. The routine MONITORING recommendations in the MAHC can be reconsidered to potentially include routine MONITORING for microbial parameters if compelling scientific data indicate that such testing provides additional, measurable public health protections beyond use of BEST PRACTICES for DISINFECTION in AQUATIC VENUE operation and maintenance. It should be noted that this section of the Annex is a minimum guideline for microbiological MONITORING. AQUATIC VENUE operators wishing to achieve additional microbial water quality characterization are encouraged to use the references in this Annex regarding water quality MONITORING techniques and STANDARDS established by the United States and in other countries. Microbial water quality STANDARDS established for AQUATIC VENUES by United States and international agencies include:

- ***Alberta Public Health***, Alberta Regulation 293/2006 (2006) Swimming POOL, WADING POOL and Water Spray Park Regulation; Alberta, Canada
  - Paraphrase, Page 10, Bacterial Limits: Heterotrophic Plate Count less than 100/mL; *Pseudomonas aeruginosa* 0/100 mL, coliforms 0/100 mL
- ***Code de la Santé Publique, France***, (2007) Arrêté préfectoral en date du 15 juin 2007 fixant les upermens du contrôle sanitaire de la qualité des eaux des piscines *(Prefectural order dated June 15, 2007 establishing STANDARDS for the control of swimming POOL water quality)*
  - Paraphrase: Determination of the parameters to be analyzed in the field or laboratory:

STANDARDS for Bacteriological Analytical Parameters

Viable aerobic bacteria at 37°C	<100/ml
Total coliforms	<10/100ml
Fecal coliforms (*E. coli*)	0/100ml
Pathogenic staphylococci	0/100ml
Pseudomonas aeruginosa (in SPAS)	0/100ml

- ***New Jersey Department of Health and Senior Services*** (2018) New Jersey State Sanitary Code, Chapter IX, Public Recreational Bathing N.J.A.C 8:26
  - Paraphrase: pages 21 – 22; Heterotrophic plate count do not exceed 200 colonies per 1 milliliter sample; Coliforms to be less than one colony per 100 milliliter sample, *Pseudomonas aeruginosa* not to exceed one colony per 100 milliliter sample.

Although routine microbial testing is not recommended by the MAHC at this time, microbiological testing can be useful as supporting data for evaluating the need for *(or effectiveness of)* troubleshooting activities,

remediation activities, and AQUATIC FACILITY upgrades. As indicated by WHO[56] recommendations, microbiological testing of water samples from AQUATIC VENUES can be useful for the following reasons:

- Before an AQUATIC VENUE is used for the first time,
- Before it is put back into use after it has been shut down for repairs or cleaning,
- If there are difficulties with the treatment system, or
- As part of any investigation into possible adverse effects on BATHER or PATRON health.

It is known that certain microorganisms, because of their ecology or structure, can be tolerant of chemical DISINFECTANTS *(e.g., CHLORINE, bromine)*. *Legionella pneumophila*, *Pseudomonas aeruginosa*, *Cryptosporidium*, *Entamoeba histolytica* cysts, and *Mycobacterium avium* complex are a few examples of pathogenic microbes that have been reported to show some tolerance to chemical DISINFECTANTS. In addition, sessile (in the biofilm) microorganisms in biofilm are likely to receive additional protection from oxidizers *(such as CHLORINE)* when the exposure concentration of these oxidizers is reduced at the interface with the biofilm due to reaction with biofilm material. Biofilm is a complex community of microorganisms which attach to the sides, piping, and filters of AQUATIC VENUES.[177] Even at elevated concentrations, oxidizing and non-oxidizing chemicals have reduced effectiveness in controlling biofilm when their concentrations and contact times are not sufficient for penetrating the biofilm.[114] Biofilm formation in AQUATIC VENUES is also a concern because microorganisms in the biofilm or the biofilm itself can detach and multiply.[178] Following BEST PRACTICE guidelines for AQUATIC VENUE cleaning and continuous DISINFECTION is critical to avoid biofilm growth and expansion problems.[179, 180] If biofilm-related problems arise, it can be useful to incorporate biofilm sampling to develop a comprehensive evaluation of the risk factors for water quality impairment and potential solutions to identified problems.[181] MAHC Annex Table 4.7.3.6 *(below)* identifies microorganisms for which chlorination may have, or is known to have, reduced efficacy.[174, 182, 183] MAHC Annex Table 4.7.3.6 also identifies methods that may be used to detect these microbes in AQUATIC VENUE systems, but the methods identified are not necessarily rapid. Additional research is needed to evaluate the benefits of microbiological testing data for AQUATIC VENUES, especially for improving public health protection. This is particularly important for the protozoans, amebas, and sessile bacterial pathogens that co-exist in biofilms. It should be noted that the use of fecal indicator organisms for AQUATIC VENUE water quality evaluation might not be sufficient for certain AQUATIC VENUE operation and management, and public health investigations, especially in public health investigations related to inhalation, skin, or ocular exposure routes. Since health risks in AQUATIC VENUES and similar environments might be fecal or non-fecal in origin, investigation of fecal indicators and non-fecally-transmitted microorganisms (e.g., *P. aeruginosa*, *S. aureus*, and *Legionella* spp.) might be warranted. It is not feasible or cost effective to test for all infectious organisms. Therefore, MAHC Annex Table 4.7.3.6 identifies those organisms which have readily available test methods or cause illnesses that are common, very serious, or fatal. It is important to note that these test methods might not allow for rapid remediation, decision making, or public health intervention on a timely basis. The Heterotrophic Plate Counts *(HPC)* method has not been included in the list of microbial water quality tests in MAHC Annex Table 4.7.3.6. While HPC data are generally a good indicator of microbial water quality and efficacy of POOL operations *(e.g., water treatment)*, this parameter has been reported to show no correlation to the presence of *Legionella*[184], planktonic pathogens[181], or the presence of biofilm[180]. HPC tests *(as do all culture tests)* under-report the actual concentration of viable bacteria. Therefore, it is recommended that the use of this test be restricted for assessing the level of planktonic, non-pathogenic bacteria only. HPC data are not sufficient to assess the public health risk of POOLS, SPAS, and waterparks[185]. Since the MAHC is intended to be a living document with changes anticipated as our knowledge increases, it is prudent to acknowledge that a paradigm shift is occurring in the world of microbiology that likely will impact how pathogen testing will be conducted and interpreted in the future. Culture tests are gradually being replaced with culture-independent test methods such as Polymerase Chain Reaction *(PCR)* testing and microarray testing. Years ago, when PCR was first used commercially, the cost of the tests was prohibitively expensive. Now test costs have decreased and are competitive with culture dependent tests. A recent development is the commercialization of microarray testing which can screen for the presence of a wide variety of bacterial and viral pathogens without the need for an isolation step. However, the costs associated with microarray testing are prohibitively expensive as of this MAHC publication. In addition to the use of STANDARD culture-based fecal indicator bacteria (FIB) tests in recreational water testing *(i.e., total and fecal coliforms, E. coli and*

enterococcus), EPA provides recommended criteria values for states that want to use a quantitative polymerase chain reaction *(qPCR)* method for Bacteroides and Enterococcus testing as a possible replacement for these culture tests. In addition, EPA has developed a qPCR method for *E. coli* which is being tested at Great Lakes Beaches. Two of the most compelling reasons for why some states would consider the use of the qPCR method are:

- Incubation times for culture tests prevent quick decision-making to minimize public exposure to water with a potentially elevated disease risk, and
- Molecular tests are generally considered to have higher specificity (lower false positive rates) than traditional culture tests.

Table 4.7.3.6: Known Pathogenic Organisms of Concern in Chlorinated Aquatic Venues (continued on next page)

Organism	*Illness*	*Route of Infection*	*Resistant to Chlorine*	*Environmental Biofilm Amplification*	*Test Method*
***Pseudomonas aeruginosa*[1]**	• Hot tub folliculitis • Conjunctivitis • Pneumonia • Swimmer's ear	• Skin • Eyes • Inhalation • Ears	• Yes, when planktonic (186, 187) • Yes, when sessile in biofilms	Yes	• APHA Standard Method 9213 E-F • APHA Standard Method Rapid PCR test available
Enteric Bacteria	• Gastroenteritis • Hip and knee joint replacement infections, replacement heart valve infections • Conjunctivitis • Pneumonia	• Fecal/Oral • Skin breaks • Eyes • Inhalation	• No, when planktonic • Yes, when sessile in biofilm	Yes	• APHA Standard Method for Coliforms 9221 A-F • APHA Standard Method 9260 A-L for specific pathogens • APHA pathogen specific PCR test • Bacteroides/Enterococci PCR tests under investigation by EPA to replace Coliforms
Legionella	• Legionnaires' disease, Pontiac fever • Hip and knee joint replacement infections, replacement heart valve infections	• Inhalation • Skin breaks	• Yes, when planktonic (179, 188) • Yes, when sessile in biofilm	Yes	• APHA Standard Method 9260 J • CDC/ISO Method is Gold STANDARD • APHA Standard Method • Rapid PCR test
***Mycobacterium avium* complex (MAC)**	• Hypersensitivity pneumonitis • Dermatitis	• Inhalation • Skin Breaks	• Yes, when planktonic • Yes, when sessile in biofilm	Yes	• APHA Standard Method 9260 M • Rapid PCR
***Staphylococcus aureus* & Methicillin resistant *Staphylococcus aureus* (MRSA)**	• Conjunctivitis • Antibiotic resistant skin infection possibly fatal	• Eyes • Skin Breaks	• No, when planktonic • Yes, when sessile in biofilm	Yes	• APHA Standard Method 9213 B 6 • and 7 • Rapid PCR test

Organism	*Illness*	*Route of Infection*	*Resistant to Chlorine*	*Environmental Biofilm Amplification*	*Test Method*
Naegleria fowleri	• Primary amoebic meningoencephalitis (uncommon but high mortality rate)	• Water in nose or pharynx	• Yes, when planktonic	Yes	• APHA Standard • Method PCR test
Acanthamoeba	• Conjunctivitis and keratoconjunctivitis (can cause blindness particularly in contact lens wearers)	• Eye, skin, mucous membranes	• Yes, when sessile in biofilm	Yes	• APHA Standard Method 9711 C
Cryptosporidium* and *Giardia	• Gastroenteritis • Biliary tract infections • Reactive arthritis	• Fecal/Oral • Inhalation	• (Oo)cysts are resistant in planktonic and sessile forms	Yes	• STANDARD Method 9711 B • APHA PCR test
Adenoviruses	• Conjunctivitis • Gastroenteritis	• Eyes • Fecal/Oral	• No	Unknown	• Cell culture • PCR
Enteroviruses	• Gastroenteritis • Viral meningitis	• Fecal/Oral	• No	Unknown	• APHA Standard Method 9510 • EPA Method 1615
Noroviruses	• Gastrointestinal	• Fecal/Oral	• No	Unknown	• EPA Method 1615 • RT-PCR Methods
Helminths and Roundworms	• Ascariasis • Baylisascariasis	• Fecal/Oral	• Cysts are resistant in planktonic and sessile forms	Yes	• APHA Standard Method 10750 • PCR tests available for species identification
Fungi	• Ringworm	• Skin	• Spores are resistant	Yes	• Culture and PCR tests

Table 4.7.3.6 Notes:

a. Many elderly or immunocompromised people use SPAS, making them more susceptible to disease.
b. *P. aeruginosa* can be tolerant of CHLORINE and is found in biofilm.
c. Hot tub folliculitis is the most common illness associated with hot tubs.
d. Coliform testing is not an indication of *P. aeruginosa* contamination.
e. Since this is a non-reportable disease, we have no information on the incidence of disease.

PCR can be a good method for investigating whether pathogenic microbes were present in AQUATIC VENUES *(e.g., sampling filter backwash)* since the technique detects the DNA of pathogens regardless of whether they are viable and culturable, dead, or viable-but-not-culturable. Another benefit is that PCR culture tests can be completed in hours versus days. However, while PCR can be effective for determining whether pathogens have been present in an AQUATIC VENUE, the technique is less effective as a measure of DISINFECTION effectiveness since it detects DNA from both viable and non-viable organisms. New techniques, such as the use of propidium monoazide *(PMA)* have been reported to enable PCR to characterize the viability status of microorganisms, so in the future PCR may be an effective option for DISINFECTION studies[189].

4.7.4 Water Replenishment System

A WATER REPLENISHMENT SYSTEM allows for POOL water to be removed from the POOL and properly disposed of so that it can be replaced with fresh water containing lower concentrations of dissolved CONTAMINANTS. A WATER REPLENISHMENT SYSTEM should be used to control the dissolved organic CONTAMINANT concentrations *(e.g., sweat, oils, chlorination by-products, and urine)* and dissolved inorganics *(e.g., salts and metals)* because POOL filtration systems are not effective at removing dissolved CONTAMINANTS.

4.7.4.1 Discharge and Measure

A means of intentionally discharging and measuring or calculating the volume of discharged POOL water *(in addition to the filter backwashing system)* should be provided and designed to discharge a volume of water of up to 4 gallons *(15 L)* per BATHER per day per AQUATIC FACILITY through an air gap. Knowing pump GPM and knowing how much time one is backwashing can be used to calculate the volume discharged. Water replacement or replenishment at a rate of 8 gallons *(30 L)* per BATHER per day per AQUATIC VENUE[56, 116, 145] has been widely used. PWTAG[116] states that as much as half of the recommended amount could be associated with filter backwashing. There does not appear to be any research to support the use of the 30 L/day/BATHER number used abroad. So, since 4 gal/day/BATHER is roughly half of this amount *(and typically met by filter backwashing alone)*, it seems like a reasonable place to start incorporating this practice into operations. A requirement could be made once the science is there to support a higher or lower value. With a WATER REPLENISHMENT SYSTEM in place, AQUATIC FACILITY operators will be able to experiment with higher water replenishment rates to obtain improved water *(and indoor air)* quality. It should also be easy to comply with any future regulations related to water replenishment as only the flow rate would require adjustment. Water replenishment for a large AQUATIC FACILITY would be based on the number of BATHERS in the entire AQUATIC FACILITY *(not the total number swimming in a particular AQUATIC VENUE on a given day since most BATHERS are expected to distribute the BATHER COUNT over a range of AQUATIC VENUES or rides on a given day)*. However, water replenishment should be proportional to the number of BATHERS in each individual treatment system. It would not be allowable to send to waste all the water from one AQUATIC VENUE and none from the other AQUATIC VENUES *(unless the water was shared through a combined AQUATIC VENUE treatment system)*.

4.7.4.1.1 Alternate Systems

The CODE allows for use of alternate systems to meet the intent for removal of turbidity, organic carbon, and nitrogen-based compounds. Discharging POOL water serves to remove compounds of public health interest *(e.g., chloramines, particles/pathogens, TDS, UVT, and organic compounds attached to particles)*. While most alternate systems that remove dissolved organic compounds *(e.g., nanofiltration and reverse osmosis)* also remove particles, there are several treatment systems *(e.g., granular activated carbon or ion exchange)* that would target organics without removing particles, pathogens, TDS, or chloramines.

4.7.5 Spas

4.7.5.1 General

Portable SPAS are not excluded from use in public settings. However, the design, operation, and maintenance of portable SPAS must conform to this CODE.

4.8 Decks and Equipment

4.8.1 Decks

4.8.1.1 General Standards for All Decks

4.8.1.1.1 Lifeguard Placement and Safety Considerations

See MAHC 4.6.5.1 and 6.3.3.1.1 for operational considerations in design.

4.8.1.1.1.1 Deck Clearance

Four feet *(1.2 m)* of clearance would allow for safe movement of a roaming QUALIFIED LIFEGUARD or for extrication in case of an emergency. This is consistent with the design guidance of the MAHC.

4.8.1.1.1.2 Access Points

In locations where PERIMETER DECK is non-contiguous and the clearance is not at least 4 feet *(1.2 m)*, such as where fencing is provided around elevated POOL edges and LAZY RIVERS, locations for lifeguards to safely access the POOL edge should be required. This facilitates a safe entry rather than climbing over any fence or other obstruction.

4.8.1.1.1.3 Bather Zone Surveillance

Designers have historically added AQUATIC FEATURES that are not readily visible on a site plan nor are their effects self-evident until installed during construction. This could create small blind spots, and thus, the need for additional lifeguards to facilitate zone coverage. For this reason, this line item was added for the designer to consider.

4.8.1.1.5 Concrete Decking

See ACI 302.1R-15, Guide for Concrete Floor and Slab Construction.

4.8.1.2 Standards for Perimeter Decks

The term "PERIMETER DECK" refers to the area around and immediately adjacent to the POOL. This area is the wettest area of the DECK and extends out from the edge of the POOL a maximum of 4 feet *(1.2 m)* or out to DECK drains, whichever is farther. Finish materials for the PERIMETER DECK must be suitable for the POOL environment, non-toxic, and substantially impervious. See MAHC 4.8.1.4.

4.8.1.3 Drains

4.8.1.3.1 Slope

Table 4.8.1.3 Minimum Slopes for Drainage

Surface	Minimum Slope
Smooth finishes, such as tile, hand-finished concrete & lightly-broomed concrete	1/8 inch per foot *(3.2 mm/30.5 cm)*
Moderately textured finishes, such as exposed aggregate or medium-broomed concrete	1/4 inch per foot *(6.4 mm/30.5 cm)*
Heavily textured finishes, such as brick *(where permitted)*	3/8 inch per foot *(9.5 mm/30.5 cm)*

MAHC Table 4.8.1.3 was created after reviewing and refining information from existing state CODES and established STANDARDS. Fundamentally, these sources all seek to eliminate standing water from the DECK, typically recognizing that smoother surfaces convey water more efficiently than rougher ones. Relating slopes to texture, rather than specific materials, provides the ability for any otherwise suitable DECK material or finish to be considered by the adopting jurisdiction. There is an inherent conflict in sloping of DECKS. Steeper slopes provide more construction tolerance and surety in conveying water, particularly in active soil conditions. Shallow slopes are required to meet accessibility guidelines – particularly for cross-slopes. It is the intent of this section to encourage positive and proper drainage without running afoul of accessibility guidelines.

4.8.1.3.3 Cross-Connection Control

Consult AHJ regarding specific chemical handling and use to properly dispose, including discharge to the watershed or sanitary sewers where appropriate.

4.8.1.3.3.2 No Drain

This requirement prevents sewage from backing up into the AQUATIC VENUE water. This isolates the treated system and does not allow mixing of other sources of water that could contaminate.

4.8.1.4 Materials / Slip Resistance

4.8.1.4.2 Slip-Resistance

Industry STANDARDS have changed to reflect a more accurate method for determining slip resistance which has been adopted by the Tile Council of North America *(TCNA)*. Historically, "SLIP-RESISTANCE" has been defined as having a minimum coefficient of friction of 0.6 for all wet surfaces and 0.8 for ramped surfaces. This static coefficient of friction is often linked to ADAAG. However, ADAAG did not set a requirement but rather referenced accessibility guidelines in the appendix that recommended *(not required)* a value of 0.6 but failed to specify a means of measurement. The recommended 0.6 value is all but meaningless without a testing method. The test method previously called for in the industry was ASTM C1028 in ANSI A137.1. The C1028 method was affected by a phenomenon called "stiction" when measuring two very smooth surfaces. This led to false expectations of slip resistance when the rubber sensor used to test for SCOF was in the presence of moisture. In Section 9.6 of ANSI A137.1, the dynamic coefficient of friction, or DCOF, is now measured. The DCOF is essentially the resistance or force that must be overcome to keep one object, already in motion, moving over another object. The test is called the DCOF AcuTest and the aforementioned "stiction" effect is eliminated. The DCOF AcuTest is also more repeatable than the 1028 method. The TCNA tested over 300 surfaces and found that on average a 0.60 SCOF correlated to a DCOF of 0.38. There have also been a number of studies done in Germany determining that the COF for reliable traction is 0.2 to 0.3, depending on the individual. When factoring in different "slippery" conditions and how different people can move on the surface, it has been determined that a minimum DCOF of 0.42 is appropriate and is now included in ANSI 137.1 for level INTERIOR SPACES expected to be walked upon when wet.

4.8.1.4.3 Carpet

Carpet and artificial turf have been found to be inappropriate finish materials for the wettest area immediately around the POOL—i.e., PERIMETER DECK. Although the materials that carpet is manufactured from are durable and do not support mold growth, when they are installed over a relatively impermeable surface, water flows very slowly through the carpet. Soil and CONTAMINANTS entering the carpet are not easily removed. Since the carpet stays wet longer, soil and CONTAMINANTS remain in the carpet, and mold and algae growth can occur. Therefore, carpeting is not an acceptable finish material in the wet PERIMETER DECK. Finish materials for the PERIMETER DECK should not block DECK drains or impair water flowing to DECK drains. Carpeting may be installed beyond the DECK drains—i.e., DRY DECK.

4.8.1.4.4 Wood

Properly treated or composite wood materials might be a suitable material for DRY DECKS provided all other decking requirements are maintained. Fasteners must be regularly inspected to ensure structural integrity and that all heads are flush or recessed into the DECK surface.

4.8.1.4.5 Dry Deck

Regional materials; local, state, territorial, and tribal practices; and particular facility design intentions vary widely with respect to DRY DECK. This section intends to provide the opportunity for regulatory oversight of DRY DECK, without limiting these variables best understood by AHJ.

4.8.1.4.6 Landscaping

It is acknowledged that landscaping near AQUATIC VENUES is not an uncommon practice in enhancing an AQUATIC VENUE environment. Landscape materials themselves and the design of special AQUATIC VENUES vary so widely as to require special consideration with respect to landscaping. This section intends to provide the opportunity to allow landscaping, but only through the lens of the AHJ. The landscaping materials are not intended to be placed in the wet PERIMETER DECK area. It is assumed here that the POOL DECK will be designed and sloped to prevent drainage from landscaping materials from reaching the POOL. For an outdoor AQUATIC VENUE, it is not possible to prevent wind from moving dirt, bugs, plant material, etc. around and perhaps into the AQUATIC VENUE. The landscape designer must consider the type and location of landscape materials placed inside or outside of an outdoor AQUATIC VENUE ENCLOSURE.

Textured Surface

The walking surface should not be rough so as to cause injury or discomfort to BATHERS. ANSI defines where a trip hazard is considered as a level change that is greater than ¼ inch *(6.4 mm)*. Other definitions include an abrupt or unexpected level change in surfaces.

4.8.1.5 Deck Size/Width

Traditional AQUATIC VENUES should be surrounded by clear DECK space to allow for operational flow *(foot traffic)* as well as space to perform rescues, CPR, or first aid in the event of an emergency. Non-traditional AQUATIC VENUES such as LAZY RIVERS, WAVE POOLS, etc. are not required to have clear space around due to the need to control access by providing a BARRIER to block access into unapproved entry areas. Both guarded and unguarded AQUATIC VENUES should have the same clear space requirements.

4.8.1.5.1 Perimeter Deck

4.8.1.5.1.1 Width

The 4 foot *(1.2 m)* unobstructed DECK area is intended to ensure a minimum clear area for emergency access and care around the POOL. Examples of obstructions include but are not limited to INFINITY EDGES, ADAAG transfer walls, and curbs.

4.8.1.5.1.2 Perimeter Decking

Most POOLS require continuous DECKS to safely accommodate circulation of all PATRONS and staff in the AQUATIC VENUE.

4.8.1.5.1.3 Unguarded Aquatic Venues

Unguarded AQUATIC VENUES require special consideration for DECK access.

- Option 1 ensures the entire perimeter is available for assistance.
- Option 2 allows for incorporation of leisure amenities and AQUATIC VENUE features such as "INFINITY EDGES" and landscaping, while maintaining assurance that the entire AQUATIC VENUE can be reached with STANDARD SAFETY equipment.

Individual requests for variance could accommodate different designs.

4.8.1.6 Wing Walls or Peninsulas

4.8.1.6.1 No Perimeter Deck

A WING WALL or PENINSULA is intended to provide separation of different areas in a POOL. The separated areas may have differing uses, flow rates, currents, or water depths.

4.8.1.6.2 Perimeter Overflow System

The MAHC defines WING WALLS as interior elements of the POOL and interior to the perimeter overflow system, so it was thought it was not appropriate to say that WING WALLS longer than some specified length should require perimeter overflow systems. It would be a function of the width of the WING WALL as to whether or not it can be properly constructed. If the POOL has a gutter system, it will probably need 4 feet *(1.2 m)* of width to get a normal trough on either side. SKIMMERS could achieve this for narrower walls because they could be staggered.

4.8.1.6.3 Pool Perimeter

WING WALLS do not contribute to the overall POOL perimeter so should not be included in AQUATIC VENUE perimeter calculations that are used as part of multiple critical design calculations.

4.8.1.6.5 Deck Drainage

It was thought that DECK drains should not be required on WING WALLS since they are considered part of the POOL and not subject to regular foot traffic. As for DECK level POOLS, the WING WALLS would be at or below water level making drains impractical.

4.8.1.7 Islands

A 7 foot *(2.1 m)* minimum clearance overhead is required since it is consistent with requirements of building CODE minimum ceiling clearances.

4.8.1.8 Heated Decks

Heated DECKS are occasionally used in cold climates to provide pedestrian paths to and around outdoor heated AQUATIC VENUES. This section provides that when heated DECKS or snow-melt systems are provided, a minimum slope must be uniformly provided. Clear delineation is required because icy areas or pathway edges near otherwise DRY DECK pose an unsafe condition.

4.8.2 Diving Boards and Platforms

4.8.2.1 Diving Envelope

When diving boards or diving platforms are installed, it is important for the SAFETY of the diver to have a diving envelope that minimizes the possibility of a diver striking any surface of the POOL structure *(walls, bottom, upslope)*. The diving envelope requirements consist of a set of minimum water depths and dimensions that a POOL is designed and constructed to which has been determined to be acceptable for the specified height of the diving board above the water surface. All minimum dimensions are established based on the diving board or diving platform plummet point. The plummet is a plumb and vertical line passing through the end of a diving board or diving platform at its centerline. Minimum dimensions set the distance and water depth from the plummet back to the POOL end wall, the water depth and overhead clearance at the plummet, the distance and depths from the plummet to walls or slopes at the side, the distance and depths ahead of the plummet before the POOL bottom may slope up, the maximum slope up, and distances ahead to the closest POOL wall. Diving from diving boards and diving platforms is divided into two categories:

- Competitive Diving utilizes springboard heights of 1 meter and 3 meters above the water surface and diving platform heights of 5-meter, 7.5-meter, and 10-meter, with 10-meter being the most common. Competitive divers range from school-age through adults, with various sanctioning bodies setting the rules for the competition.
- Non-Competitive or Recreational Diving can utilize any diving board or diving platform height, but jumpboard or springboard heights 1 meter or less above the water surface are typically used, with ½ meter and ¾ meter boards the most common. Recreational boards less than 1 meter above the water surface are shorter in length and less flexible than 1-meter springboards. Although non-competitive boards could be between 1 meter and 3 meters in height, since manufacturers only make 1 meter and 3-meter boards, boards between these heights are not common.

Note concerning diving from a POOL DECK: Because of the danger of catastrophic spinal cord injury *(SCI)* due to the lack of a safe diving envelope, no head-first dive should ever be attempted from a POOL DECK where the water is less than 5 feet deep. See MAHC 4.5.19.4 NO DIVING MARKERS and MAHC Annex 4.5.19.4.1 discussion. This CODE is designed to encourage POOLS to be built to the STANDARDS of the agency that will certify the diving at the AQUATIC FACILITY. The CODE dimensions are purposely a compilation of the most conservative STANDARDS of diving envelope dimensions and are in no way intended to supersede the certifying agencies dimensions, but instead are intended to be used only when there is no certifying agency for the AQUATIC FACILITY. Since NCAA, USA Diving, and WORLD AQUATICS do not have STANDARDS for diving boards less than 1 meter in height, the State of Michigan table (Public Swimming Pools R 325.2133 Diving areas and facilities; "plummet" defined, Table 1), shown as MAHC Table 4.8.2.2 in the CODE, was revised to the most conservative STANDARD found for 0.5-meter and 0.75-meter diving boards. These minimum dimensional requirements were then dictated to be more conservative in certain instances based largely on interpolations. Concerning use of diving boards higher than 1-meter, these diving boards are not recommended for non-competitive use. However, if the diving boards are constructed to this CODE or NCAA Standards, then non-competitive use can be allowed under careful adult supervision or with QUALIFIED LIFEGUARDS on duty. However, non-conformance with these STANDARDS is unsafe for recreational diving purposes.

4.8.2.1.1 Competitive Diving

The diving envelope STANDARDS for various competitive diving board and platform heights is well established by certifying agencies such as NCAA, WORLD AQUATICS, and USA Diving. When POOLS are designed to these competitive diving envelope STANDARDS, POOL bottom contact injuries are very rare; however, injuries due to contact with the board or platform do happen.

4.8.2.1.2 Non-competitive Diving

AQUATIC VENUES with non-competitive or recreational diving from boards or platforms, typically have boards that are less than 1 meter, such as ½ meter or ¾ meter installed. There might also be boards greater than 1 meter installed. Since the certifying agencies only certify 1-meter and 3-meter boards for competition only, the diving envelope STANDARDS in MAHC tables 4.8.2.2 and 4.8.2.3 and MAHC Figures 4.8.2.2.1 and 4.8.2.2.2 must be used with non-competitive height boards.

4.8.2.2 Steps and Guardrails

Diving boards and diving platforms are accessed from the POOL DECK by ladders and stairways. Just as providing a safe diving envelope protects the diver once they have left the board, it is essential that a diver can safely access the diving board elevation above the POOL DECK. There have been substantial injuries and numerous deaths associated with falls from the ladder to or from 3-meter boards onto concrete DECK below. Guardrails or protective BARRIERS that are properly designed and provided on each side of a diving board, prevent a person from falling off a board and landing on the POOL DECK. In addition, the guard rail/ handrail design must address the ability of the diver to grip and maintain a sufficient grip to prevent a fall from the ladder. Studies regarding handhold designs and the impact on breakaway strength *(the maximum force that can be exerted on an object before it is pulled or slips from the grasp of the hand)* for children and adults have been conducted and indicate that the diameter of the handhold and vertical orientation significantly impact the breakaway strength.[190, 191] Using a stairway instead of a ladder is an alternate way to provide for safe access. change requests *(CRs)*, requiring the use of stairs instead of ladders to access diving boards or platforms greater than 1 meter in height when used for recreation, have been submitted. The CRs did not pass primarily due to the concern over availability of manufacturers of diving board stairs, associated cost of stairs, and the impact on AQUATIC VENUE space design due to the larger footprint. Although the CRs did not pass, the supporting information regarding injuries and handrail design to accommodate sufficient grip for SAFETY is relevant and included in this Annex discussion. It should be considered for future CRs for improvement of SAFETY when accessing diving boards/platforms. Supporting documentation submitted includes the Public Playground Safety Handbook, Consumer Product Safety Commission, December 29, 2015; Standards Australia AS 1657-2013 Fixed platforms, walkways, stairways, and ladders – Design, construction, and installation; and several research publications detailing the abilities of children to grasp handholds of various diameters, orientations, and friction.[190-194]

4.8.2.2.4 Tall Platforms

Access to tall platforms is provided by stairways or fixed vertical ladders. There have been injuries and even deaths associated with falls from fixed vertical ladders providing access to 3-meter boards to the POOL DECK below. The handhold diameter and orientation are significant factors in the ability to support one's weight from a handhold particularly on fixed vertical ladders where one hand might be supporting the full body weight if the feet slip off the ladder rungs. The best diameter and spacing of the handhold vary based on the age of the user. These factors must be considered in the design to minimize the risk of falls given the falls can and have resulted in deaths.

Appropriate warnings and restrictions should be noted on the ladders similar to other types of ladders. These could include age restrictions, directions for use *(i.e., always face ladder, hold onto ladder with both hands, climb up slowly)* and warnings *(i.e., failure to follow instructions might result in injury or death)* shall be displayed on the ladder. The use of resilient surfacing at the base of vertical ladders could reduce the severity of or prevent injury.

4.8.3 Starting Platforms

4.8.3.1 Conform to Standard Codes

The intent is to require a minimum 6-foot *(1.8 m)* water depth under the starting platform and the oversight of an aquatics governing body (e.g., WORLD AQUATICS, USA Swimming, NCAA, NFHS, YMCA, etc.) or a coach or instructor. WORLD AQUATICS, USA Swimming, NFHS, and the NCAA allow 6 feet *(1.8 m)* at starting platforms. Although there are some national data on SCIs in general, data on diving-specific SCIs are limited, particularly for SCIs involving public POOL-related competition diving.

General Data on Spinal Cord Injuries and Other Diving Injuries:

For SCIs in general, approximately 40 SCIs/million population occur each year in the US (about 12,400 injuries for 2010) with approximately 4.5% related to diving injuries.[64] SCIs are a catastrophic public health problem leading to disability and decreased life expectancy[65] with a large economic and social burden for those who suffer the injury[65, 66]. In a study of U.S. emergency department (ED) data from 2006–2014, an estimated 83,000 ED visits for injuries occurred as a result of diving into swimming POOLS. The majority were male, and significantly more patients were ages 15–24 years. Spinal cord injuries were more common in those over age 25 years, whereas intracranial injuries occurred more frequently in younger patients. The total charges for the six-year period approached $620 million.[70]

Non-Deck Level Diving, Competition Diving, and SCIs:

Data related to SCIs occurring as a result of competition diving off starting platforms are limited. Since starting platforms are several feet above the POOL, the entering velocity of swimmers is greater than for DECK level diving making it more difficult to alter trajectory once executed[195]. One large study investigated 74 SCIs in non-competitive divers occurring with use of springboards or jumpboards; 45% of the POOLS were public[69]. Of these injuries, 12.2% occurred in water less than 4 feet *(1.2 m)*; 66.2% occurred in water less than 5 feet *(1.5 m)*; 94.6% occurred in water less than 6 feet *(1.8 m)*. All SCIs occurred in water of less than 7 feet *(2.1 m)*. The MAHC requires that starting blocks be removed, if possible, or blocked off to prevent recreational divers from using them when not in use by competitive swimmers. Data demonstrates that competitive swimmers can be trained to perform shallow water dives from starting blocks to reduce the risk of SCIs[196-198]. As a result, competitive aquatics governing bodies *(e.g., WORLD AQUATICS, U.S.A. Swimming, NCAA, NFHS, YMCA)* allow starting blocks to be placed over water as shallow as 4 feet *(1.2 m)* in depth as long as competition is conducted under the auspices of the governing body or by a coach or instructor. A progressive training regimen can be used so that diver training is conducted in deeper water until the diver has mastered the technique before the certified personnel approve their starting block entries into shallower depths[199]. However, further data are needed on the adequacy of an intervention, like training, that relies on correctly performing a technique to prevent injury; aquatics governing bodies state they have not documented injuries since this progressive training regimen has been adopted. However, it is noted that high speed video of competing athletes during competition dives from starting platforms illustrates the following:

- About 3% of athletes diving into 4 feet *(1.2 m)* of water[200] *(the POOL had the minimum depth recommended for athletes using starting blocks)* touched the bottom;
- Nearly half approach within 0.5 meters *(1.6 ft)* of the bottom;
- Over half exceeded head speed thresholds deemed possible to cause severe head trauma; and
- There was some anecdotal information suggesting some divers touched intentionally.

Conversely, filming of athletes diving into 7.5 feet *(2.3 m)* of water *(the POOL studies exceeded Olympic competition depths of 6.5 feet (2.0 m) below starting platforms)* showed that very few swimmers approach to within even 1 meter *(3.3 ft.)* of the POOL bottom[201]. These data suggest that injury risk from using starting platforms is likely to be higher for older, presumably heavier, or inexperienced divers, particularly when diving into shallower depths.

Future Directions and Research

The MAHC recommends that these national data be re-analyzed with aquatics in mind to gather more detailed information on SCIs and other injuries related to diving in treated AQUATIC VENUES, particularly public AQUATIC VENUES to further inform this discussion. Future analysis of national data should be undertaken, if possible, to assess the occurrence of SCIs in competitive swimmers and platform heights and water depths at which the injury occurred. Analysis of data in peer-reviewed publications or reports collected by aquatics governing groups on SCIs and other diving injuries would also be important to understand POOL-specific diving injuries occurring in competitive swimmers and the efficacy of current progressive training or other interventions.

4.8.4 Pool Slides

4.8.5 Lifeguard- and Safety-Related Equipment

4.8.5.2 Safety Equipment Required at all Aquatic Facilities

4.8.5.2.1 Emergency Communication Equipment

A communication device is required in the MAHC 5.8.5.2.1, but it also needs to be considered in the design so the designer can plan for the wiring for such devices. Consider larger facilities or other types of facilities that might have a phone in the nearby building. Consider a telephone labeled with location of phone/address. Some facilities might be so equipped to properly respond to an event and phones might not be required. Large AQUATIC FACILITIES with lifeguard/trained response may not need phones installed everywhere. The intent is for BATHERS to have access to a phone to call for help when help is not necessarily part of the AQUATIC FACILITY operation. QUALIFIED LIFEGUARDS or other emergency response staff are to be trained and might have communication devices such as whistles or radios which initiate their emergency response which includes the ability to contact outside emergency personnel when necessary. Often AQUATIC VENUES can be at a distance from support personnel and the designer should consider methods for personnel to communicate whether via radio, telephone, intercom, or other method. For alternate communication systems or devices, the intent is that an emergency phone or communications system or device is immediately available to PATRONS from all AQUATIC VENUES within an AQUATIC FACILITY. Some alternate communication systems might include a handset or intercom system to a location that is constantly manned whenever the AQUATIC VENUE is open for use *(e.g. a front desk at a hotel, the check in desk at a fitness club, or other continuously manned location)*; a commercial emergency contact device that connects to a MONITORING service, or directly to 911 dispatch; or devices that alert multiple staff onsite when activated *(e.g. pagers systems, cellular telephone systems and radio communication alert systems)*. Also see MAHC 5.8.5.2.1 for additional requirements.

4.8.5.3 Safety Equipment Required at Facilities with Lifeguards

4.8.5.3.1 Lifeguard Chair and Stand Placement

This section refers to only those chairs that are permanently installed and does not indicate that a permanent chair or stand is required. The location of the chairs must give the QUALIFIED LIFEGUARD complete visibility of all parts of the zone of PATRON surveillance. The number of chairs is determined by the ability to provide surveillance of the AQUATIC VENUE by creating zones of PATRON surveillance. It is intended that the designer should be working with an aquatic consultant, the owner, or operator to make sure the location of chairs and stands allows for clear line of sight.

4.8.5.3.2 Lifeguard Chair and Stand Design

Chairs and stands are exposed to elements; therefore, they should be made to withstand the environment. The intent for such a chair is to facilitate better surveillance and such the chair should be elevated sufficiently above the heads of BATHERS to have a better view and combat glare. Considerations for the SAFETY of QUALIFIED LIFEGUARDS using these chairs should include access and egress as well as BARRIERS to unauthorized access if installed at an elevation.

4.8.5.3.3 UV Protection for Chairs and Stands

Protection from UV radiation exposure can include a shade attached to the stand, a shade structure external to the stand, or other types of shade such as surrounding features. The designer should consider which method will be employed to provide UV protection for the stand.

4.8.6 Barriers and Enclosures

4.8.6.1 General Requirements

The MAHC tried to distinguish the word "BARRIER" from "ENCLOSURE." Those definitions are in the glossary. As currently defined, a "BARRIER" is simply intended to be an obstacle intended to deter direct access from one point to another. For example, a simple post and rope solution would meet MAHC intent.

4.8.6.2 Construction Requirements

4.8.6.2.1 Discourage Climbing

Many POOL CODES refer to a 4-inch *(10.2 cm)* sphere in the body of the CODE. From a building CODE perspective, this is not consistently enforced, and these CODES don't regulate that small of an opening. Building CODES allow STANDARD 2 ¼ inch *(5.7 cm)* mesh fencing and is not necessarily specific for AQUATIC

VENUES. Building CODES typically dictate minimum height and proximity to property lines - unless it's a fall issue. With AQUATIC FACILITIES, we are mainly concerned with discouraging unauthorized entry / break-ins.

4.8.6.2.2 Emergency Exit Paths

It is the intent of this section to prevent emergency egress routes from exposing building occupants to unguarded AQUATIC VENUE areas. It is not the intent of this section to permanently segregate multiple AQUATIC VENUES on the same site. Temporary or seasonal ENCLOSURES *(properly maintained and employed)* may be used to segregate paths of egress from a building or adjacent AQUATIC VENUE to SAFETY. For example, where a seasonal outdoor AQUATIC VENUE is operated in conjunction with a year-round indoor AQUATIC VENUE, a seasonal exit pathway separation ENCLOSURE may be used to maintain exiting in the off-season. During the outdoor swim season *(when the outdoor AQUATIC VENUE is in operation)*, it is acceptable to egress via the AQUATIC VENUE DECK to EXIT GATES.

4.8.6.2.4 Height

The issue was discussed at length. The prevailing "BEST PRACTICE" in the industry is for 4 foot *(1.2 m)* high fencing around unguarded AQUATIC FACILITIES. However, the MAHC decided to make the ENCLOSURE height the same for all AQUATIC FACILITIES *(6 feet or 1.8 meters)* since 4-foot fences are scalable even with smaller mesh. Generally, even unguarded AQUATIC FACILITIES have some hours of use and these POOLS also need to discourage use outside of operational hours by youth and others. The MAHC's collective logic was that if an AQUATIC FACILITY is designed for unsupervised use at all times then there is no real advantage to a fence higher than 6 feet *(e.g., 8 feet or taller)*.

4.8.6.2.4.3 Other Barriers Not Serving as Part of an Enclosure

The 42-inch *(1.1 m)* BARRIER height is consistent with STANDARD building CODE requirements for a guardrail, which serves substantially similar purposes. This height provides for consistency across CODES for like appurtenances.

4.8.6.3 Gates and Doors

This section is intended to address large AQUATIC FACILITIES where there might either be multiple AQUATIC VENUES, multiple grade elevations, or both. EXIT GATES must be provided to permit adequate emergency egress. For example, an AQUATIC FACILITY with ten AQUATIC VENUES split between different grade elevations should have the required number of exits spaced reasonably around the perimeter and not all at one grade elevation.

4.8.6.3.1 Self-Closing and Latching

4.8.6.3.1.1 Self-latching Device Height

The NCHS's Anthropometric Reference Data for Children and Adults[202] demonstrates the mean height of a 6-year old child in the United States is 47 inches *(119.3 cm)* and the mean height for a 5-year old is 44.8 inches *(113.7 cm)*. If one adds the reach height of a 5- to 6-year old child above the head this is approximately 54 to 57 inches. Raising latch heights from 3.5 ft *(42 inches, 1.1 m)* to 4.5 ft *(54 inches, 1.4 m)* will put the latch out of the average 5-year-old child's reach. Exception 2 of Section 404.2.7 of the 2010 ADAAG allows for an increase in the maximum height of operable parts *(defined in Section 106.5 as "a component of an element used to insert or withdraw objects, or to activate, deactivate, or adjust the element")* of gate and door hardware from 48 inches *(1.22 m)* maximum above the finish floor or ground to 54 inches *(1.37 m)* maximum above the finish floor or ground, for operable parts of the release of latch on self-latching devices of access gates in ENCLOSURE walls and fences protecting AQUATIC VENUES, provided the self-latching devices are not also self-locking devices and operated by means of a key, electronic opener, or integral combination lock.

4.8.6.3.1.6 Exceptions

The exceptions in MAHC 4.8.6.3.1.6 are intended to provide flexibility for design with an equivalent means of PATRON SAFETY. It is recommended that during the design phase the AQUATIC FACILITY consider and plan for operation of the AQUATIC FACILITY to meet the exemption, including an assessment of the need for additional personnel for staffing or supervision.

- ***Exception 1:*** MAHC 4.8.6.3.1.6.1 is intended to provide relief from MAHC 4.8.6.3.1 at locations where there is a staffed entrance which is locked when the AQUATIC FACILITY or AQUATIC VENUE is not open to the public. If Exception 1 is used, the AQUATIC FACILITY should clearly outline in the Staffing Plan *(part of the SAFETY PLAN required in 6.3.3)* the necessary staffing of any gate or door designed per the Exception and operate in accordance with the approved SAFETY PLAN. Use of video surveillance is not considered an acceptable alternative to having staff physically present at such entrances.
- ***Exception 2:*** MAHC 4.8.6.3.1.6.2 is intended to provide relief from MAHC 4.8.6.3.1 in instances where a required AQUATIC FACILITY or VENUE ENCLOSURE surrounds one or more AQUATIC VENUES where a QUALIFIED LIFEGUARD*(s)* is provided to conduct PATRON surveillance at all times the AQUATIC VENUE*(S)* is open, and where the gate or door is locked at all times the AQUATIC FACILITY or AQUATIC VENUE is closed to the public. Note that to comply with Exception 2, all AQUATIC VENUES within the AQUATIC FACILITY or VENUE ENCLOSURE must have a QUALIFIED LIFEGUARD present, even if not otherwise required per MAHC 6.3.2. If an AQUATIC FACILITY is not otherwise required to provide a QUALIFIED LIFEGUARD(s) at all AQUATIC VENUES within the ENCLOSURE, to meet Exception 2, any AQUATIC VENUE within the ENCLOSURE not provided with a QUALIFIED LIFEGUARD*(s)* would need to have a separate ENCLOSURE with gates or doors designed per MAHC 4.8.6.3.1 or 4.8.6.3.1.6.1. If Exception 2 is used, the AQUATIC FACILITY must clearly outline in the Staffing Plan *(part of the SAFETY PLAN required in MAHC 6.3.3)* any additional supervision provided by a QUALIFIED LIFEGUARD*(s)* to meet Exception 2 and operate in accordance with the approved SAFETY PLAN.

4.8.6.4 Indoor Aquatic Venues

4.8.6.4.3 Indoor and Outdoor Aquatic Venues

If a seasonal AQUATIC VENUE is on the same property as an AQUATIC VENUE operated outside of that same season, PATRONS need to be prevented from accessing the closed AQUATIC VENUES.

4.8.6.4.4 Wall Separating

A minimum overhead clearance of 6 feet 8 inches *(2.0 m)* is required since it is consistent with requirements of building CODE minimum doorway clearances. Materials that do not pose a possibility of physical injury may be suspended from the structure to help contain the INDOOR AQUATIC FACILITY environment.

4.8.6.5 Multiple Aquatic Venues

Rationale of 24 inch *(61.0 cm)* deep rule is that if adjacent water is not substantively deeper than the WADING POOL, there is no need to segregate the two. If it is the only AQUATIC VENUE within the facility, then normal fencing and perimeter ENCLOSURE requirements would apply. If WADING POOLS are a part of a larger facility with other types of AQUATIC VENUES, then the requirements proposed in MAHC 4.12.9.2 would apply.

4.8.7 Aquatic Venue Cleaning Systems

The MAHC encourages draining SPAS for cleaning. A vacuum likely would not be required for very small AQUATIC VENUES, such as SPAS less than 75 square feet *(7.0 m^2)*. A simple wall brush with pole can adequately and efficiently clean the floor.

4.8.7.1 No Hazard

Pumps shall not exceed three horsepower because the suction hydraulic of a larger pump through the small vacuum tubing would force the pump to operate at unacceptable hydraulic conditions. Strong suction forces provide a greater risk for bodily harm in the event of a vacuum system mishap. POOL vacuum systems must use suitably-sized pumps, proper diameter vacuum hoses, and reasonable hose lengths to provide optimum hydraulics for vacuuming operations. Conventional suction requirements call for a maximum 15 feet *(4.6 m)* of water at a flow of 4 GPM per lineal inch of suction cleaner head for the total suction head loss.

4.8.7.6 GFCI Connection

Not allowing extension cords prevents the possibility that the high voltage power supply unit has enough cord to potentially be dragged into the POOL causing a potential SAFETY risk. The power cord length needs to be

shorter than the distance between the receptacle and the edge of the POOL to prevent the power supply from accidentally entering the POOL water while connected.

4.9 Filter/Equipment Room

4.9.1 Equipment Room

If possible, pool chemicals should be stored in dedicated CHEMICAL STORAGE SPACES with corrosion-resistant materials of construction and not in the filter/equipment room where they would be in close proximity to equipment. Fumes from halogen-based sanitizers and muriatic acid can be corrosive, particularly to the copper wiring in electronics, pool heaters, and pump motors, and thus cause costly damage to this equipment. Pool chemicals should be stored so that they are protected from getting wet (See MAHC 5.9.1.5) and access to CHEMICAL STORAGE SPACES should be limited to properly trained personnel only.

4.9.1.1 General Requirements

Building CODE speaks to minimum door widths from an egress standpoint which is typically narrower. The height is consistent with building CODE requirements. To prevent equipment damage and accidental exposures for maintenance and operations personnel, pool chemicals should be stored in dedicated storge rooms constructed with corrosion-resistant materials and not in close proximity to filtration, recirculation, heating, disinfection and other related equipment.

4.9.1.2 Construction

- See IMC Section 304.1.
- See NEC Article 110-26: Minimum Clearances.
- See NFPA 54 Section 8.1.2.

4.9.1.4 Ventilation

- See IMC Section 502.

4.9.1.5 Markings

Pipes may be color coded according to use with either labels or a reference chart; directional arrows with permanent labeling on the pipes; or by other means deemed suitable by the AHJ.

4.9.1.6 Equipment Rooms Containing Combustion Equipment

Due to the CORROSIVE nature of chemicals being used in the water treatment process, it should be expected that all equipment, especially combustion equipment and any ancillary components, experience corrosion. A breach in the combustion chamber or failure of the combustion air damper could lead to carbon monoxide release into the EQUIPMENT ROOM OR AREA which can prove fatal to occupants. The carbon monoxide detectors, CERTIFIED, LISTED, AND LABELED in accordance with UL 2075, should be tested, at a minimum, semiannually to ensure their operability. All combustion chambers, combustion dampers, and ancillary items associated with the combustion system, should be inspected annually to ensure they are intact, operating correctly, and not in danger of corroding through. Inspections should be carried out by qualified parties. Where local, state, territorial, federal, and tribal health inspectors do not have the proper training or knowledge to perform these tests and boiler inspections, operators should contract for the required tests and inspections by qualified parties. Health inspectors should review the facility's paperwork to confirm that they have had the required tests and inspections completed.

Installed

No CODE language exists for this section since the MAHC defers to other CODES but the rationale for some of it is still included in the Annex. No items should be installed, nor shall STORAGE be planned for any items, within the minimum clearances of a COMBUSTION DEVICE, as defined by the manufacturer, or within the minimum clearances as defined the National Fuel Gas Code or other applicable local, state, territorial, federal, and tribal laws, whichever are greater.

- See IMC Section 304.1.
- See NFPA 54 Sec. 8.1.2.

Increased Ventilation

Rooms containing combustion equipment might be subject to requirements for increased ventilation and combustion-air intake, as specified by the National Fuel Gas Code or other pertinent CODES. The EQUIPMENT ROOM OR AREA should be constructed as to allow for the planned equipment or should be modified as necessary. Where an EQUIPMENT ROOM OR AREA contains combustion equipment which uses EQUIPMENT ROOM OR AREA air for combustion, no other equipment should be so installed as to reduce the room air pressure beyond the acceptable air-intake pressure range for the combustion equipment.

- See IMC Section 701.

Noxious Gasses

All practical flames produce carbon monoxide or nitrous oxides. There is very little chance of being rid of both at the same time. Neither is good for human health. The key is to dilute combustion products and send them up the flue. This does not always work where EQUIPMENT ROOM OR AREA air pressure is lower than outdoor air pressure. Some COMBUSTION DEVICES work by natural draft *(buoyancy of hot gases)* and cannot tolerate any pressure difference. Other COMBUSTION DEVICES have higher pressure differences which they can overcome. Where an EQUIPMENT ROOM OR AREA contains combustion equipment which uses EQUIPMENT ROOM OR AREA air for combustion, air-handling equipment should not use the room as a plenum. Exceptions may include where the combustion equipment is CERTIFIED, LISTED, AND LABELED for the expected use, such installation shall be acceptable where approved by the AHJ.

- See IMC Section 701.

Plenum Room

A plenum room uses the EQUIPMENT ROOM OR AREA as the intake duct for HVAC equipment. Thus, it will have a low air pressure while the HVAC equipment is operating. For an INDOOR AQUATIC FACILITY, the incoming air would contain halogen compounds *(e.g., chloramines)*, and thus, should never be used as combustion air. Where an EQUIPMENT ROOM OR AREA contains combustion equipment which uses a draft hood, air-handling equipment should not use the room as a plenum. Exceptions may include where the combustion equipment is CERTIFIED, LISTED, AND LABELED for the expected use, such installation shall be acceptable where approved by the AHJ.

- See IMC Section 701.

Lowered Room Pressure

In this situation, there is a tendency for the lowered room pressure to pull combustion products back down the flue into the room, and thus spread them everywhere. Rooms containing combustion equipment are also subject to requirements for separation from CHEMICAL STORAGE SPACES.

4.9.1.7 Separation from Chemical Storage Spaces

Largely, building STANDARDS do not speak to AQUATIC VENUES; for example, the dangers that chemical fumes pose to combustion equipment.

4.9.1.7.1 Equipment

4.9.1.7.1.1 Contaminated Air

Combustion equipment, air-handling equipment, and electrical equipment should not be exposed to air contaminated with CORROSIVE chemical fumes or vapors.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See Chimney Safety Institute of America (Plainfield, IN): Proper Venting of Gas Fueled Appliances, 2010.
- See NFPA 54 Section 8.1.6.
- See Propane Council (Washington, D.C.): Instruction Sheet IV - Identifying and Correcting Burner Problems.

4.9.1.7.1.2 Equipment Restrictions

Spaces containing combustion equipment, air handling equipment, or electrical equipment and spaces sharing air distribution with spaces containing such equipment shall not at the same time be used as CHEMICAL STORAGE SPACES. Exceptions may include equipment CERTIFIED, LISTED, AND LABELED for use in that atmosphere shall be acceptable, where approved by the AHJ.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See IMC Section 304.1

4.9.1.7.1.3 Isolated

Spaces containing combustion equipment, air-handling equipment, or electrical equipment and spaces sharing air distribution with spaces containing such equipment shall be isolated from CHEMICAL STORAGE SPACE air.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See IMC Section 304.1.

4.9.1.7.2 Doors and Openings

4.9.1.7.2.1 Between Equipment and Chemical Storage Spaces

A door or doors should not be installed in a wall between such EQUIPMENT ROOMS OR AREAS and an interior CHEMICAL STORAGE SPACE.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See IMC Section 304.1.

4.9.1.7.2.2 No Openings

CHEMICAL STORAGE SPACE door*(s)* must not be left open. This is important to controlling air pressure ratios, keeping CORROSIVE gases out of COMBUSTION DEVICES, and keeping children away from hazards. There should be no ducts, grilles, pass-throughs, or other openings connecting such EQUIPMENT ROOMS OR AREAS to CHEMICAL STORAGE SPACES.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See IMC Section 304.1.

4.9.1.7.2.3 Indoor Aquatic Facility Air

Spaces containing combustion equipment, air-handling equipment, or electrical equipment and spaces sharing air distribution with spaces containing such equipment should be isolated from INDOOR AQUATIC FACILITY air. Exceptions may include equipment listed for the atmosphere, which may be acceptable.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See Chimney Safety Institute of America (Plainfield, IN): Proper Venting of Gas Fueled Appliances, 2010.
- See NFPA 54 Section 8.1.6.
- See Propane Council (Washington, D.C.): Instruction Sheet IV - Identifying and Correcting Burner Problems.

Combustion equipment cannot be allowed to intake halogen compounds because acids will form in the flue and destroy it, allowing carbon monoxide and other combustion products to enter the occupied space.

4.9.1.7.2.4 No Openings

There should be no ducts, grilles, pass-throughs, or other openings connecting such spaces to an INDOOR AQUATIC FACILITY. Exceptions may include HVAC equipment which is rated for INDOOR AQUATIC FACILITY atmosphere and which serves only that INDOOR AQUATIC FACILITY shall be acceptable.

Note: Ducts which connect the INDOOR AQUATIC FACILITY to the duct connections of air handlers should not be construed as connecting the air-handler space to the INDOOR AQUATIC FACILITY.

- See ANSI/ACCA 10 Manual SPS Section 1-6.
- See IMC Section 304.1.

4.9.1.7.2.5 Openings / Gaps

Where building construction leaves any openings or gaps between floors and walls, or between walls and other walls, or between walls and ceilings, such gaps should be permanently sealed against air leakage.

- See ANSI/ACCA 10 Manual SPS Section 12-3.

4.9.1.7.3 Indoor Aquatic Facility Access

4.9.1.7.3.1 Floor Slope

Where a door or doors must be installed in a wall between an EQUIPMENT ROOM OR AREA and an INDOOR AQUATIC FACILITY, the floor of the EQUIPMENT ROOM OR AREA should slope back into the EQUIPMENT ROOM OR AREA in such a way as to prevent any EQUIPMENT ROOM OR AREA spills from running under the door into the INDOOR AQUATIC FACILITY. Exceptions may include:

This may be met by a floor all of which is at least 4 inches below the level of the nearest part of the INDOOR AQUATIC FACILITY floor.

This may be met by a continuous dike not less than 4 inches high located entirely within the EQUIPMENT ROOM OR AREA, which will prevent spills from reaching the INDOOR AQUATIC FACILITY floor.

Note: EQUIPMENT ROOM OR AREA floor drains may be required, and all designs shall be compliant with ADAAG as they may be applicable.

Cleaning Supplies

Even if POOL chemicals and cleaning supplies are not in the EQUIPMENT ROOM OR AREA, there is a very good chance that other fluids might be present *(e.g., ethylene-glycol heating fluids, petroleum refrigeration oils, polyol-ester refrigeration oils, alkyl-benzene refrigeration oils, other lubricants, caustic or acidic coil cleaners, etc.)*.

4.9.1.7.3.2 Automatic Closer

Such door or doors should be equipped with an automatic closer. The door, frame, and automatic closer shall be installed and maintained to ensure that the door closes completely and reliably without human assistance.

4.9.1.7.3.3 Automatic Lock

Such door or doors should be equipped with an automatic lock. Such lock shall require a key or combination to open from the INDOOR AQUATIC FACILITY side. Such lock should be so designed and installed as to be opened by one hand from the inside of the room under all circumstances, without the use of a key or tool.

4.9.1.7.3.3.1 Restrict Access

Such doors should be equipped with permanent signage warning against unauthorized entry.

4.9.1.8 Other Equipment Room Guidance

4.9.1.8.1 Access Space

Where ventilation, air filtration, or space dehumidification, heating, or cooling for an INDOOR AQUATIC FACILITY is by mechanical equipment located in an EQUIPMENT ROOM OR AREA, adequate access space should be provided to allow for inspection and service.

- See IMC Section 304.1.
- See NFPA 70 Article 110-26: Minimum Clearances.
- See NFPA 54 Section 8.1.2.

4.9.1.8.1.1 Size Requirements

The access spaces should be the greater of:

- Those required by OSHA, NEC, National Fuel Gas Code, or other official requirements; or
- The equipment manufacturer's recommendations.

4.9.1.8.2 Adequate Space

Where ventilation, air filtration, or space heating or cooling for an INDOOR AQUATIC FACILITY is beside mechanical equipment located in an EQUIPMENT ROOM OR AREA, adequate space for required straight lengths of duct shall be provided as the greater of those described in AMCA 201, SMACMA HVAC Systems Duct Design, ANSI/ACCA 10 Manual SPS, or the equipment manufacturer's recommendations.

- See ANSI/ACCA 10 Manual SPS Sections 1-6 and 13.
- See AMCA 201.
- See SMACNA HVAC Systems Duct Design.

4.9.1.8.3 Minimize Hazards

- See 29 CFR 1926.1053 Ladders.
- See ANSI/ACCA 10 Manual SPS Section 1-6.

4.9.1.8.4 Refrigeration Equipment

Most refrigerants are heavier than air. When released from containment, most will evaporate rapidly, expanding greatly in the process. If a large enough amount is released, it could displace air to above head-height. For this reason, mechanical CODES usually require refrigerant-release to the outdoors when the amount of refrigerant exceeds some fraction of the occupied volume.

4.9.2 Chemical Storage Spaces

POOL chemical injuries have been routinely documented.[159, 160, 203-207] For 2007-2008, 32 POOL chemical--associated health events that occurred in a public or residential setting were reported to CDC by Maryland and Michigan. These events resulted in 48 cases of illness or injury; 26 (81.3%) events could be attributed at least partially to chemical handling errors *(e.g., mixing incompatible chemicals)*. ATSDR's HSEESS received 92 reports of hazardous substance events that occurred at AQUATIC FACILITIES. More than half of these events *(55 [59.8%])* involved injured persons; the most frequently reported primary contributing factor was human error. Estimates based on CPSC's NEISS data indicate that 13,508 *(95% confidence interval [CI]: 9,087–17,929)* ED visits attributable to POOL chemical injuries occurred during 2015–2017; the most frequent diagnosis was poisoning *(5,245 ED visits [95% CI: 3,135–7,355])*. CDC has developed recommendations to reduce the risk of POOL chemical injuries at AQUATIC FACILITIES.[207, 208] Designers and aquatics staff should read and consider findings and recommendations developed from investigations related to POOL chemical-related injuries. The design for CHEMICAL STORAGE SPACE was included in the initial version of the MAHC Ventilation and Air Quality module AIR HANDLING SYSTEM design posted for public comment. It was removed in the revised indoor AIR HANDLING SYSTEM design area of the MAHC as part of revising the definition of an INDOOR AQUATIC FACILITY for which the AIR HANDLING SYSTEM does not include CHEMICAL STORAGE SPACE or other space outside the negative pressure zone around the AQUATIC VENUE. However, the building of an INDOOR AQUATIC FACILITY will still require consideration of the ventilation of CHEMICAL STORAGE SPACES using separate AIR HANDLING SYSTEMS. Chemicals, typically stored in AQUATIC FACILITIES for the purpose of maintenance and water treatment, can create ventilation hazards for PATRONS and staff. IMC and IFC provide very specific guidance on the construction and AIR HANDLING SYSTEM design of these areas. Often AQUATIC FACILITIES store chemicals in the pump room, but the operational STORAGE of these chemicals should be limited to what is necessary for immediate use. Back up supplies should be appropriately stored and maintained in a separate area designed according to the above STANDARDS.

Other key areas to consider for proper chemical STORAGE would include:

- Follow applicable local, state, territorial, federal, and tribal building CODES or ASHRAE Standards or STANDARDS such as NFPA 5000, or IBC Section 307.
- Separate the AIR HANDLING SYSTEMS for the CHEMICAL STORAGE SPACE and pump room from the rest of the building.
- Separate the AIR HANDLING SYSTEM for the AQUATIC VENUE area from the rest of the building.
- If an older AQUATIC FACILITY does not have separate AIR HANDLING SYSTEMS for the CHEMICAL STORAGE SPACE and pump room as well as the AQUATIC VENUE area, consider installing emergency heating, ventilating, and air conditioning *(HVAC)* cutoffs in these areas.

- Ensure that the CHEMICAL STORAGE SPACE, pump room, and AQUATIC VENUE area are well-ventilated.
- Ventilate the CHEMICAL STORAGE SPACE, pump room, and AQUATIC VENUE area to the outside.

4.9.2.1 Outdoor / Indoor Storage

4.9.2.1.3 Dedicated Space

The number of required CHEMICAL STORAGE SPACES should be as necessary to allow safe STORAGE of the chemicals present.

Additional Space

Where the listing, labeling, or SAFETY data sheet *(SDS)* of chemicals indicates incompatibility of STORAGE with other chemicals present, other CHEMICAL STORAGE SPACE*(s)* should be provided.

- See ANSI/ACCA 10 Manual SPS Sections 1-6 and 12-3.
- See Calcium Hypochlorite, Sodium Hypochlorite, Muriatic Acid, BCDMH, etc., have NFPA 704 health rankings of 3
- See CDC. POOL Chemical Emergencies accessed at https://www.cdc.gov/healthy-swimming/toolkit/pool-chemical-emergencies.html.
- See EPA OSWER 90-008.1 Chemical Emergency Preparedness and Prevention Advisory SWIMMING POOL CHEMICALS: Chlorine.
- See IMC Sections 502.8.4 and 502.9.2.
- See NFPA 704.

4.9.2.1.4 Eyewash

It is the intent to allow re-fillable eyewash bottles and not require plumbed emergency eyewashes and SHOWERS unless required by the AHJ.

4.9.2.2 Construction

As applicable, the STANDARDS of NFPA 400, the IFC, and the IBC shall prevail. This STANDARD is not intended to provide relief from these other regulations, but to provide BEST PRACTICE where these regulations are not adopted or enforced. The more stringent STANDARD shall prevail as applicable.

4.9.2.2.3 Floor

The floor or DECK of the CHEMICAL STORAGE SPACE should be protected against substantial chemical damage by the application of a coating or sealant capable of resisting attack by the chemicals to be stored.

4.9.2.2.6 No Openings

Other than a possible door, there should be no permanent or semi-permanent opening between a CHEMICAL STORAGE SPACE and any other INTERIOR SPACE of a building intended for occupation.

- See ANSI/ACCA 10 Manual SPS Sections 1-6 and 12-3.
- See IMC Section 502.
- See NFPA 704.
- See SDS for calcium hypochlorite, hydrochloric acid, muriatic acid, and sodium hypochlorite.

4.9.2.3 Exterior Chemical Storage Spaces

As applicable, the STANDARDS of NFPA 400, the IFC, and the IBC shall prevail. This STANDARD is not intended to provide relief from these other regulations, but to provide BEST PRACTICE where these regulations are not adopted or enforced. The more stringent STANDARD shall prevail as applicable.

4.9.2.3.2 Enclosure

It is a very important SAFETY feature that CHEMICAL STORAGE SPACES be completely surrounded by an ENCLOSURE to prevent PATRONS from entering the CHEMICAL STORAGE SPACE.

4.9.2.4 Chemical Storage Space Doors

As applicable, the STANDARDS of NFPA 400, the IFC, and the IBC shall prevail. This STANDARD is not intended to provide relief from these other regulations, but to provide BEST PRACTICE where these regulations are not adopted or enforced. The more stringent STANDARD shall prevail as applicable.

4.9.2.4.1 Signage

Given the high TURNOVER RATE or potential for employees to travel between workplaces at some AQUATIC FACILITIES, it would seem prudent to require a posting of the SDS location. Specifying the location of the SDS on the actual entry door to the chemical space might help reduce time for a response to an event. It further strengthens the requirements of OSHA 1910.1200(g)(8), 1910.1200(g)(9), and 1910.1200(g)(10)

- See NFPA 704 "Hazard Identification System."

4.9.2.4.2 Emergency Egress

This usually takes the form of a kick-out panel in the door. When trapped, a person can sit down and kick out the panel, creating an opening usually about 6 inches *(15.2 cm)* narrower than the door and about 28 inches *(71.1 cm)* high. Since these are used in most ENCLOSURES where a person can be trapped *(e.g., walk-in freezers)* the volume is high enough for additional expense to be minimal. Trapping could happen in several ways, but the most common is binding of the door to the jamb. Corrosion products can build up inside a metal door between the jamb and the wall, forcing the jamb away from the wall and toward the door. At some point the door will either fail to open or fail to close.

4.9.2.4.3 Interior Door

Safety Data Sheets *(SDS)* for sodium hypochlorite, calcium hypochlorite, hydrochloric acid, and muriatic acid.

4.9.2.4.4 Equipment Space

- See ANSI/ACCA 10 Manual SPS Sections 1-6 and 12-3.
- See Canadian Standards Association C22.2.
- See Chimney Safety Institute of America, Plainfield, IN
  - Proper Venting of Gas Fueled Appliances, 2010
- See NEC Art. 110.11: *Deteriorating Agents*.
- See NEMA 250.
- See NFPA 54 Section 8.1.6
- See Propane Council (Washington, D.C.). Instruction Sheet IV: *Identifying and Correcting Burner Problems*.
- See UL 50 and UL 508.

4.9.2.4.4.1 Corrosive

Combustion equipment cannot be allowed to intake halogen compounds because acids will form in and destroy the flue. Air-handlers have strong negative air pressures inside them. This will draw in any CONTAMINANTS around the cabinet and distribute throughout the ducted system.

4.9.2.4.5 Interior Opening

4.9.2.4.5.2 Automatic Locks

Most locks for employee-only doors in public buildings would qualify, since such locks must lock automatically from the outside, but cannot require a key or tool for exit. Examples of suitable lock types would include but are not limited to, the locks on hotel-room doors, the lock on the door of a personnel-file STORAGE SPACE, the lock on a janitor's closet, etc.

- See ANSI/ACCA 10 Manual SPS Sections 1-6, 4-4, and 12-3.

4.9.2.5 Interior Chemical Storage Space

As applicable, the STANDARDS of NFPA 400, the IFC, and the IBC shall prevail. This STANDARD is not intended to provide relief from these other regulations, but to provide BEST PRACTICE where these regulations are not adopted or enforced. The more stringent STANDARD shall prevail as applicable.

4.9.2.5.1 No Air Movement

- See ANSI/ACCA Manual SPS 2010 Section 4-4.

4.9.2.5.2 Electrical Conduit System

An interior CHEMICAL STORAGE SPACE that shares any building surface *(wall, floor, ceiling, door, etc.)* with any other INTERIOR SPACE or that shares an electrical-conduit system with any other space should be equipped with a ventilation system that maintains the air pressure in the CHEMICAL STORAGE SPACE below that of any other INTERIOR SPACE by 0.05–0.15 inches *(1.3–3.8 mm)* of water pressure or by such greater pressure difference as should be necessary to ensure that all air movement through building surfaces or conduits should be toward the CHEMICAL STORAGE SPACE.

Note 1: *This can usually be accomplished by maintaining the air pressure in the CHEMICAL STORAGE SPACE at least 0.05–0.15 I.W.C. below that of any adjoining space and below that of any space connected to the CHEMICAL STORAGE SPACE by an electrical conduit system. Larger pressure differences might be needed in special cases.*

Note 2: Where:

- All conduits passing through the CHEMICAL STORAGE SPACE use only threaded joints within the CHEMICAL STORAGE SPACE, and
- All conduits terminating in the CHEMICAL STORAGE SPACE
  - Are effectively sealed, and
  - Use only threaded joints within the CHEMICAL STORAGE SPACE, the specified air-pressure difference need not include the air pressures of INTERIOR SPACES which do not share a building surface with the CHEMICAL STORAGE SPACE.

4.9.2.5.2.2 Pressure Difference

This pressure difference should be maintained by a continuously operated exhaust system used for no other purpose than to remove air from that one CHEMICAL STORAGE SPACE.

4.9.2.5.2.4 Alarm

- See ANSI/ACCA 10 Manual SPS Sections 1-6, 4-4, and 12-3.
- See ASHRAE Handbook: HVAC Applications, 2019, Places of Assembly, Natatoriums, Section 4.6: Ventilation Requirements.
- See IMC 502.1.
- See Safety Data Sheets for calcium hypochlorite, hydrochloric acid, muriatic acid, and sodium hypochlorite.

4.9.2.6 Air Ducts in Interior Chemical Storage Spaces

4.9.2.6.1 No Air Movement

- See IMC Section 502.1.
- See ANSI/ACCA 10 Manual SPS Sections 1-6 and 4-4.

Ducts should not be shared between spaces. Should the blower stop or fail, there would be cross-contamination.

4.9.2.8 Combustion Equipment in Interior Chemical Storage Spaces

- See NFPA 54 Section 8.1.6
- See Chimney Safety Institute of America, Plainfield, IN; Proper Venting of Gas Fueled Appliances, 2010
- See Propane Council, Washington DC; Instruction Sheet IV: Identifying and Correcting Burner Problems

4.9.2.11 Gaseous Chlorination Space

Many current jurisdictions closely regulate the use of gas CHLORINE from a disaster preparation and response standpoint. This can make CHLORINE gas use prohibitive from a regulatory standpoint to the point that its use is difficult to justify.

4.9.2.12 Windows in Chemical Storage Spaces

4.9.2.12.1 Not Required

These windows are sometimes built into the door, although not always. *(There are fire-rated doors with windows.)* Such windows may serve several purposes.

4.9.2.12.2 Requirements

Such windows are usually installed for free lighting, although there can be drawbacks. Some chemicals can react on exposure to sunlight.

4.10 Hygiene Facilities

4.10.1 General

Language similar to that of this section is found in most state CODES.

4.10.1.2 Minimum to Provide

During 2015–2019, 76 *(81.8%)* treated recreational water–associated outbreaks were caused by *Cryptosporidium*[33]. These cryptosporidiosis outbreaks can disproportionately affect children ages less than 5 years and can cause community-wide outbreaks[164]. Infectious *Cryptosporidium*[119] OOCYSTS' extreme CHLORINE tolerance allows them to survive for more than 7 days when FREE CHLORINE concentrations are maintained at 1mg/L[127, 128]. The OOCYSTS small size *(4.5 µm x 5.5 µm)* also allows them to bypass typical sand and cartridge filters[209]. While SECONDARY TREATMENT or SUPPLEMENTAL TREATMENT SYSTEMS can inactivate the OOCYSTS, UV and ozone treatment systems are circulation dependent so can require extended times for inactivation of pathogens in the POOL.[168, 210-213] Thus, changing BATHER behavior in the following ways are needed to help prevent cryptosporidiosis outbreaks:

- Enforcement of policies that exclude swimmers sick with diarrhea,
- PATRON and staff education about hygienic swimming behaviors *(e.g., taking a CLEANSING SHOWER before entering the water, not swallowing AQUATIC VENUE water)*.

Chloramines

During January–March 2007, over 660 BATHERS and aquatic staff at a waterpark experienced respiratory symptoms and eye irritation caused by chloramines.[28] Chloramines form when free chlorine oxidizes nitrogenous compounds *(e.g., sweat, urine, and personal care products)* that wash off BATHERS' bodies. Chloramines can volatilize into the air and accumulate in air of indoor AQUATIC VENUES. One in five *(17%)* American adults reports having ever urinated in a POOL[214], and elite athletes can sweat over 700 mL/h[215]. Rinsing off in the SHOWER for 60 seconds and wearing bathing caps significantly decreases the amount of total organic carbon and total nitrogen[4]. Studies also suggest that UV treatment can reduce chloramine concentrations in the water[216, 217]. Accumulation of chloramines in the air at indoor AQUATIC VENUES can be reduced with the following practices:

- Policies that require showering before entering the water,
- PATRON and staff education about hygienic swimming behaviors *(e.g., taking a RINSE SHOWER and using the toilet before entering the water, not urinating in the POOL, and wearing bathing caps)*,
- Using UV water treatment, and
- Improving ventilation.

4.10.1.5 Theoretical Peak Occupancy

The minimum number of RINSE SHOWERS and CLEANSING SHOWERS should have PLUMBING FIXTURE counts correlated directly to the THEORETICAL PEAK OCCUPANCY in MAHC 4.1.2.3.5. Any PLUMBING FIXTURE counts above this should be accordance with the AHJ's requirements.

4.10.2 Location

4.10.2.1 Distance

The intent of this CODE item is to discourage PATRONS from drinking POOL water and encourage them to keep themselves hydrated. The intent is also to encourage PATRONS to use the HYGIENE FACILITIES rather than urinating in the POOL or changing diapers at the side of the AQUATIC VENUE or on AQUATIC VENUE furniture. Restrooms need to be easily accessible and available to PATRONS of AQUATIC VENUES so that they will use restrooms rather than urinating or defecating in the venue water. Compared with other public locations, people might feel that it is more acceptable to "pee in the POOL" and not use sanitary facilities for this bodily function. This might not be possible in large waterparks. However, they can possibly be located within 300 feet *(91 m)* from the AQUATIC VENUE. The distance needed for parents to walk or carry children ages less than 5 years should be shorter *(200 ft or 61 m)* to ensure use. These distances are found in multiple state or local CODES including Wisconsin, Oregon, Florida, and New York. When possible, it is preferable to have a bathroom on the same floor as the AQUATIC VENUE; however, it is not required at this time in the MAHC. Drinking water should be available so that PATRONS, especially young children, are less likely to drink AQUATIC VENUE water and to ensure that PATRONS are kept well-hydrated.

4.10.2.2 Children Ages Less than Five Years

There are specific types of AQUATIC VENUES that pose an increased risk of fecal contamination of the water by BATHERS such as WADING POOLS, water ACTIVITY POOLS, interactive water play venues, or other AQUATIC VENUES designed primarily for children ages less than 5 years. For these AQUATIC VENUES, diaper-changing areas should be located directly adjacent to the kiddie areas to promote use. It is especially important that HYGIENE FACILITIES be available to these young BATHERS. Children ages less than 5 years have the highest incidence of reported diarrheal illness and are more likely to be a source for spreading diarrhea-causing pathogens.

4.10.3 Design and Construction

Language similar to this section is found in most state CODES.

4.10.3.2 Floor Base

The purpose of coving is to prevent water splashing on the wall when mopping. Six inches *(15.2 cm)*, a common height, was taken from building CODE.

For further information, also see the FDA Food Code for Kitchens.

4.10.3.3 Floor Drains

4.10.3.3.1 Opening Grill Covers

Holes in floor drain cover openings need to be sized to prevent small children's toes from becoming entrapped when walking over them.

4.10.3.3.2 Sloped to Drain

Floors not sloped to drain have been shown to allow bacterial growth on indoor and outdoor AQUATIC VENUE POOL DECKS.

4.10.3.5 Hose Bibb

The purpose of these hose bibs is to permit adequate cleaning of SHOWER and toilet facilities and to permit cleaning of any spills occurring in the HYGIENE FACILITY. See also MAHC 6.5 for further rationale.

4.10.4 Plumbing Fixture Requirements

Language similar to this section is found in most state CODES.

4.10.4.1 General

4.10.4.1.1 Protected

It is fundamental that there be no CROSS-CONNECTIONS between safe *(potable)* and unsafe *(non-potable)* water supplies. All hose bibbs should be equipped with a vacuum breaker to prevent back siphonage. This CROSS-CONNECTION protection can also be achieved at lavatories and laundry tub washing facilities through an air gap. As a general rule, the INLET pipe is terminated at a distance about two times the diameter of the pipe and not less than 6 inches *(15.2 cm)* above the maximum overflow level of the PLUMBING FIXTURE rim.

4.10.4.1.3 Toilet Counts

Facilities in jurisdictions with requirements governing the number of sanitary facilities should follow those requirements. AQUATIC FACILITIES with an average PATRON load of over 100 persons should follow the IPC. Facilities with average PATRON loads of less than 100 persons should follow either the IPC or UPC. The IPC might require substantially more toilet facilities for women than for men.

Potty Parity

(Abstracted from ICBO adoption materials) Previous issues of the nation's model consensus CODE mandated an equal amount of toilet FIXTURES for both men and women. Newer versions of the CODE will likely provide recommendations that increase the minimum required facilities for women. The IPC requires far less HYGIENE FIXTURES for various types of occupancies than the UPC. This is contrary to the "potty parity" movement which demands more FIXTURES for women's toilet rooms to avoid the long waiting lines. The UPC also provides more WCs and urinals in most men's toilet rooms than the IPC and assures adequate WCs by limiting the number that can be deleted by installing additional urinals. The authors of the ICBO have suggested that the provisions of the UPC reflect what the "potty parity movement" called for. The provisions of the IPC do address the issue of "potty parity." The issue of "potty parity" is mostly an issue in assembly buildings with large occupant loads, especially where there is a period of high demand such as at intermission at a theater or at halftime at a football stadium. "Potty parity" is not an issue for occupancies where there is no instantaneous demand on the FIXTURE usage. IPC Table 403.1 reflects requirements for twice as many PLUMBING FIXTURES in the ladies' room compared with the men's room, when the type of occupancy demands such a count. In occupancies where the factors do not demand such an increase, the CODE does not require it. It should also be pointed out that part of this issue arises because of some CODES requiring both WCs and urinals within the men's restroom. Therefore, the numbers for men were somewhat higher. The IPC does not have a mandatory requirement for urinals. It will generally require the same number of PLUMBING FIXTURES in the men's and women's restrooms. However, when two or more WCs are required, the IPC will permit up to 67%of the FIXTURES to be replaced by urinals.

Some differences between the IPC and UPC CODES on this issue are as follows:

International Plumbing Code:

- Utilizes a fixed PLUMBING FIXTURE to occupant load ratio.
- Does not mandate urinals for men.
- Allows up to 67% of the requirement for WCs to be substituted for urinals.
- Establishes a separate FIXTURE calculation factor for men and women. In some cases, twice as many FIXTURES are required for women compared with men.
- No arbitrary parity requirement.

Universal Plumbing Code:

- Utilizes a variable PLUMBING FIXTURE to occupant load ratio.
- Requires urinals to be installed based on a FIXTURE to occupant load ratio. Does not allow for one-to-one substitutions. For each urinal added over what is required, you may have one-to-one substitutions up to 2/3 of what is required.
- Requires the total number of WCs for women to be equal to the total number of WCs and urinals for men.

4.10.4.2 Cleansing Showers

The purpose of CLEANSING SHOWERS described in this section is to remove dead skin, sweat, nitrogenous waste, and perianal fecal material before BATHERS enter the POOL. This is best done through nude showering using warm water and soap. An average of 0.14 grams of fecal material can be found on a person's peri-anal

surface *(the amount of feces for children ranges from 0.01-10 grams and for adults 0.0001–0.1 g(218))*. Therefore, fecal contamination of the perianal area is common. This contamination may include the CHLORINE-tolerant parasite *Cryptosporidium*(127, 219), which is not inactivated by routine DISINFECTANT concentrations required in AQUATIC VENUES. Since the effectiveness of most halogen-based DISINFECTANTS is reduced by the presence of organic material, the purpose of CLEANSING SHOWERS is to reduce the inorganic, organic, and fecal load introduced into POOLS.

4.10.4.2.1 Count

The THEORETICAL PEAK OCCUPANCY *(MAHC 4.1.2.3.5)* has been accounted for in the one SHOWER per sex per 4000 square feet *(372 m^2)*. This assumes using one BATHER per 20 square feet *(1.9 m^2)*, so at 4000 square feet, there will be one SHOWER per 200 BATHERS. Further research on this topic is recommended and can be addressed in future versions of the MAHC.

4.10.4.2.3 Location

The placement of the SHOWERS is intended to encourage BATHERS to see and use the SHOWERS before they enter the water.

4.10.4.2.4 Enclosed

Entryways to CLEANSING SHOWER compartments shall be enclosed to provide privacy. Individual SHOWER stall curtains and doors are not required. Providing privacy for CLEANSING SHOWERS promotes BATHER cleansing prior to entering AQUATIC VENUES.

4.10.4.2.6 Exemption

"Residential settings" include condos, apartments, and homeowners' associations but does not apply to individual residential POOL settings. The intent is for BATHERS to use their rooms/homes for a CLEANSING SHOWER; however, one RINSE SHOWER on the DECK is required at these AQUATIC FACILITIES encouraging BATHERS to SHOWER prior to entering water if a BATHER had not already done so.

4.10.4.3 Rinse Showers

The purpose of the RINSE SHOWERS is to remove inorganic material such as sand or dirt that can bind with CHLORINE and reduce the amount for pathogen inactivation. Rinsing with water also removes BATHER's CONTAMINANTS such as sweat, hygiene products, deodorant, hair spray, etc. Rinsing off in the SHOWER for 60 seconds and wearing bathing caps significantly decreases the amount of total organic carbon and total nitrogen(4). A RINSE SHOWER can be taken on the DECK in open SHOWERS by the AQUATIC VENUE using water at ambient temperature, so dirt and other CONTAMINANTS are rinsed off before entering the water.

4.10.4.3.3 Floor Sloped

Floors of RINSE SHOWERS shall be sloped to drain wastewater away from the AQUATIC VENUE and any landscaping areas if present. The intent is to prevent landscaping materials from being tracked back or washed into the AQUATIC VENUE area.

4.10.4.3.4 Large Aquatic Facilities

The intent is to encourage BATHERS to see and use the RINSE SHOWERS before they enter the water.

4.10.4.3.5 Beach Entry

The intent of having at least four showerheads every 50 feet *(15.2 m)* at a beach entry allows multiple people to rinse off at the same time. Showerheads could be provided as wall units, pedestals (one pedestal could have four showerheads or two pedestals could have two showerheads each), allowing AQUATIC FACILITY owners to have versatility in design.

4.10.4.3.6 Lazy River

BATHERS enter LAZY RIVERS only in designated areas; therefore, locating RINSE SHOWERS near these entrances facilitates rinsing before entering the LAZY RIVER.

4.10.4.3.7 Waterslide

BATHERS congregate into queue lines for access to WATERSLIDES. Providing a RINSE SHOWER on the DECK of a queue line encourages use prior to entering the water.

4.10.4.4 All Showers

The intent is to encourage use of showering prior to entering an AQUATIC VENUE. Large AQUATIC FACILITIES, based on their THEORETICAL PEAK OCCUPANCY, would require a large number of CLEANSING SHOWERS which would put an economic burden on these facility types. The MAHC acknowledges CLEANSING SHOWERS are more expensive to install than RINSE SHOWERS, therefore if the required number of SHOWERS is met, AQUATIC FACILITIES can decide which type of SHOWER is conducive for their PATRONS. In addition, the ISPSC Section 609.3.1 allows flexibility on the ratio of cleansing to RINSE SHOWERS above 7,500 square feet of water surface area.

4.10.4.5 Diaper-Changing Stations

The material in this section addresses diapering of infants and young children. These are the age groups most involved in contamination of recreational water that can lead to outbreaks of illness associated with recreational water. Although some older persons must wear diapers the incontinence is less likely to be associated with a diarrheal illness so the risk of infection from adults is much less than that from children. Therefore, we do not believe that special regulations are needed for elderly BATHERS. Current DIAPER-CHANGING UNIT designs do not supply all the features needed for sanitary and efficient diaper changing and clean-up to minimize spreading pathogens further in the AQUATIC FACILITY.

The MAHC defines a DIAPER-CHANGING STATION to include the following:

- A DIAPER-CHANGING UNIT,
- An adjacent handwashing sink,
- Soap with dispenser,
- Trash receptacle, and
- Necessary cleaning materials for the DIAPER-CHANGING UNIT.

4.10.4.5.1 Each Facility

4.10.4.5.1.1 Handwashing Sink

HANDWASHING STATIONS are required adjacent to DIAPER-CHANGING STATIONS to promote use after using the toilet/urinal or changing diapers. Facilities will have 1 year after adoption on this MAHC section to install a plumbed sink with soap and dispenser, hand drying device/or paper towels and dispenser, and trash receptacle.

4.10.4.5.1.2 Portable

If a permanently plumbed handwashing sink is not economically feasible to install, a portable HANDWASHING STATION can be used as a substitute for 1 year. Portable HANDWASHING STATIONS are used at temporary events and include a water and waste tank that requires frequent refilling and draining for continual use.

4.10.4.5.2 Conform

There appear to be two different configurations of DIAPER-CHANGING UNITS currently available and suitable for this setting. The first type, a fold-down commercial unit commonly mounted on the wall, is addressed by ASTM F2285-04. The second type, a free-standing unit, is addressed by Caring for Our Children *(CFOC)*. A major difference between these two designs is that ASTM F2285 calls for restraining straps while CFOC prohibits the use of straps and relies on a 3-inch *(7.6 cm)* lip to keep children from falling off. Both designs have inherent problems. The problems with straps are associated with cleaning and possible hanging hazard. The problem with a 3-inch *(7.6 cm)* lip is that they are not available on fold-up units. The MAHC language does not discriminate between these two designs, but the unit used should conform to one of these two STANDARDS.

4.10.4.5.3 Unisex

Increasingly, many AQUATIC VENUES are providing family dressing areas and caregiver rooms to attend to family needs. This provision permits parents to attend to the needs of small children of the opposite sex.

4.10.4.5.4 Trash Can

Trash receptacles are needed to help maintain cleanliness around the DIAPER-CHANGING STATION for any disposable changing unit covers, diapers, sanitizing wipes, or disposable paper towels.

4.10.4.6 Non-Plumbing Fixture Requirements

4.10.4.6.4 Lockers

While some lockers are designed to sit directly on the floor, other lockers may need to be elevated. This prohibits water accumulation beneath the lockers. Such accumulation can lead to the growth of mold, mildew, and slime build up. The MAHC has gone with the current industry STANDARD of 3.5 inches *(8.9 cm)* high but recommends moving to a new STANDARD of 6 inches *(15.2 cm)* to allow better access, cleaning, and drying under the lockers.

4.10.4.6.6 Dryers / Paper Towels

Hand drying devices or paper towel dispensers should be located adjacent to the handwashing sinks to facilitate use. To prevent overcrowding, they may be positioned to move users away from the sink and toward the exit. In childcare settings, the dispensers and devices are usually within arm's reach of the sink.

4.10.5 Provision of Suits, Towels, and Shared Equipment

Although providing reusable bathing suits is no longer common, many AQUATIC FACILITIES provide PATRONS with towels and other shared equipment. The purpose of this wording STANDARD is to ensure that these AQUATIC FACILITIES provide adequate equipment and space in their design and construction for laundering, sanitizing, and drying these items.

4.10.6 Foot Baths

FOOT BATHS with standing water allow the buildup of organic material and bacterial and fungal growth and can lead to the spread of pathogens.

4.10.7 Sharps

This section was included to address AQUATIC VENUES that provide PATRONS with sharps, especially razors, so that safe disposal is ensured. Approved sharps containers are rigid, leak-proof, puncture resistant boxes of various sizes made of hard red plastic. They have a lid that can be securely sealed to keep contents from falling out, and they are clearly marked with the bio-hazard symbol. OSHA's Bloodborne Pathogens Standard (29 CFR 1910) describes the design and use of sharps containers for a variety of settings.

Businesses are required by OSHA's Bloodborne Pathogens Standard (29 CFR 1910) to deposit sharps into a sharps container that complies with OSHA regulations to protect employees. Once that container is full, it must be disposed of according to state and federal regulations.

4.11 Water Supply / Wastewater Disposal

4.11.1 Water Supply

4.11.1.1 Public Water System

PUBLIC WATER SYSTEMS include community water systems, non-transient non-community water systems, or transient non-community water systems with some noted exceptions.

4.11.1.1.1 Other Sources

There are several lakes, springs, private wells, or other approved private water sources around the country that have been used for decades to supply water to AQUATIC FACILITIES. Hauled water obtained from a public water supply or approved private water supply may also be used to fill POOLS. If the source water quality does not substantially change and can be treated by the AQUATIC FACILITY equipment to protect the health and SAFETY of PATRONS, it can be allowed.

4.11.1.1.2 Condensate / Reclaimed Water

The steps necessary to make reclaimed water meet source water STANDARDS are beyond the scope of the MAHC. These steps are set by the state and federal agencies that set requirements for drinking water. This would be up to the AHJ and local conditions. Considering recent affinities towards sustainability, reclaiming condensate would be acceptable if this water met the same STANDARDS as incoming domestic water *(even if this required UV or other DISINFECTANTS, filters, etc.)*. This could be challenging since some CONTAMINANTS introduced by swimmers might not be removed by filtration, UV, or other treatment. A provision for deferring to the AHJ ruling based on locale was important to include in the MAHC. For instance, this might be more of a politically important issue in Arizona or Nevada than in other areas of the country. Non-potable use for this water is in keeping with water as a limited resource.

4.11.1.2 Sufficient Capacity

This requirement is for when AQUATIC FACILITIES choose to be open when backwashing *(e.g., they can backwash one filter while still maintaining filtration through another system; operating without the RECIRCULATION SYSTEM running is prohibited)*. A facility may choose to regulate when their backwash cycles occur *(such as at closing)*. Some fully automated backwash systems for filters are programmed to backwash at night when the facility is closed and there are no other demands on the source water coming into the facility. Alternatively, QUALIFIED OPERATORS may choose for an all deep 50-meter POOL to just backwash one filter at a time and allow make-up water to reestablish rim flow before doing the next one, as opposed to doing all six or eight tanks sequentially.

4.11.2 Fill Spouts

For example, a fill spout located under a diving board or next to a ladder or handrail is less likely to be a trip hazard or be a hazard to swimmers coming up from below.

4.11.3 Cross-Connection Control

An air gap can be provided through a fill spout at the side of an AQUATIC VENUE, through water supply piping over the edge of an open balance tank or surge tank, or over a fill standpipe that is connected to the side of an AQUATIC VENUE. Splash guards are simply a means to keep fill water from splashing onto adjacent floors and walls. Water cannot be siphoned into the potable water supply through a properly designed splash guard. A proper design often consists of a concentric pipe that is a larger diameter than the fill pipe and that is open to the atmosphere at the top and bottom. Because of the potential for back pressure or back siphonage, any potable water piping connected directly to any AQUATIC VENUE piping must have an RPZ. Some permitting agencies or CODES may allow pressure vacuum breakers or atmospheric vacuum breakers on water supplies not connected to the POOL piping but supplying potable water to the AQUATIC VENUE through a submerged INLET in the AQUATIC VENUE. The pressure vacuum breaker would be located upstream of the shut-off valve. The atmospheric vacuum breaker would be located downstream of the shut-off valve.

4.11.4 Deck Drains and Rinse Showers

4.11.5 Sanitary Wastes

4.11.6 Pool Wastewater

AQUATIC VENUE waste streams *(including filter backwash water and AQUATIC VENUE drainage water)* should be discharged through an air gap to sanitary sewers, storm sewers, drain fields, or by other means, in accordance with local, state, territorial, federal, and tribal laws or recommendations including obtaining all necessary permits. The discharge should occur in a manner that does not result in a nuisance condition. Each waste line should have a unique air gap. Waste lines from different sources *(e.g., AQUATIC VENUE, SPA, overflow, sump pump, etc.)* should not be tied together, but multiple waste lines may discharge into a common sump or receptacle after an air gap. The AHJ may allow an elimination of an air gap to control splashing or flow of AQUATIC VENUE wastewater outside the receiving sump onto the EQUIPMENT ROOM OR AREA floor. This can be accomplished by extending the AQUATIC VENUE wastewater pipe below the rim of the sump. This can be approved if the wastewater disposal pipe from the AQUATIC VENUE does not have a sealed connection to the sewer piping. This constitutes an air break. An air break can be justified for the worst-case scenario of a sewer backup at the AQUATIC VENUE wastewater sump. During a sewer backup, sewage cannot back pressure into AQUATIC VENUE piping through an air break. Further, if the sewage is above the AQUATIC VENUE waste

pipe outlet when the AQUATIC VENUE is operating, the normal pressure of the POOL piping leaks AQUATIC VENUE water towards the sewer, preventing the AQUATIC VENUE piping from siphoning wastewater. If the AQUATIC VENUE is not operating, then there is no pressure or suction in the piping that could create a condition for siphoning sewage. If the permitting agency does not allow an air break, they may allow an air gap with a splash guard.

4.11.6.2 Ground Surface

Filters work to reduce the level of pathogens in the AQUATIC VENUE water by retaining the pathogen in the filter. As a result, AQUATIC VENUE backwash water has been demonstrated to contain detectable pathogen concentrations (e.g., *Cryptosporidium* and *Giardia*).[127, 130, 220] Therefore, filter backwash water should be considered wastewater requiring appropriate disposal. A ground surface discharge may be the only option for disposing wastewater from an AQUATIC VENUE. A suitable location is one where the discharged wastewater does not pond excessively, flow directly to surface water, or create other nuisance conditions. The discharge should not cross property boundaries.

4.11.6.4 Separation Tank for Precoat Media Filters

If local, state, territorial, federal, and tribal laws prohibit disposal of backwash filter media *(perlite, cellulose, or diatomaceous earth)* directly to sanitary sewer, a separation tank may be recommended. The separation tank is to be designed for the conditions of the specific facility filtration system. The separation tank should be designed to accommodate the volume of water and spent media recommended for at least a single backwash *(media change)*, without overflowing. The separation tank may include separation screens or a settling pit to allow for the spent media to be removed and properly disposed of according to AHJ requirements.

4.12 Specific Aquatic Venues

4.12.1 Spas

4.12.1.2 Maximum Water Depth

SPAS are designed for sitting and the expectation is that it will not be over the average 11-year-old child's head. That depth is about 48 inches *(1.2 m)*. The MAHC felt that 24 inches *(61.0 cm)* is reasonable since it is half of the maximum depth previously stated *(48 in or 1.2 m)* and would allow for the vast majority of the population to sit comfortably with their head above water. The MAHC also consulted the ISPSC and their maximum depth of 28 inches *(71.1 cm)* is pulled from APSP which has been utilized by the industry for some time. The Committee recommends additional studies to determine if decreasing the SPA seating depth is necessary.

4.12.1.3 Handholds

Even though a person is seated in a SPA, enough positive handholds are needed to assist with standing up. Handholds at the edge of the SPA above the water line are visible and easily reachable.

4.12.1.5 Perimeter Deck

This is to provide adequate area for life saving and rescue purposes. The AHJ may allow a smaller rescue area based on the assessment of a local emergency rescue agency. Small or narrow SPAS are examples where the AHJ may allow a relief from the 50% minimum DECK requirements. The rationale is that if a SPA is of a limited size or width then it can be entirely be guarded effectively from one side or one location.

4.12.1.5.4 Elevated Spas

SPAS elevated for transfer wall or other purposes need to be provided with an effective BARRIER so that the elevated wall is not used as a platform to access and adjacent AQUATIC VENUE. An effective BARRIER shall be one that does not allow BATHERS to walk on the elevated wall. For example, if an elevated SPA is next to or within 4 feet *(1.2 m)* of another AQUATIC VENUE, a guard rail or post-and-rope system would be a couple of options as effective BARRIERS which would discourage PATRONS to use this elevated wall to jump into the other AQUATIC VENUE.

4.12.1.7 Temperature

Temperatures above 104˚F are essentially inducing a fever in the BATHER's body as internal temperature rises. It also causes birth defects in fetuses so that pregnant women, particularly in their first trimester, should consult their healthcare provider before using. Further research is needed to understand the potential role of SPA use early in pregnancy and associated birth defects. See MAHC Annex 5.7.4.7.2 for further discussion.

4.12.1.10 Timers

The "Fifteen Minute Rule" – complies with most state CODES. The hydrotherapy jet timer is for the SAFETY of the BATHERS. Longer times can be hazardous to BATHERS and the hydrotherapy jet system shutting off at least reminds the BATHER to get out and reset the timer.

4.12.1.11 Emergency Shutoff

Emergency shutoffs should be located between 5 feet *(1.5 m)* and 50 feet *(15.2 m)* and within sight of the SPA structure.

4.12.2 Waterslides and Landing Pools

4.12.2.1 Design and Construction

The designs of WATERSLIDES are governed by amusement ride regulations such as ASTMF2376 that have appropriate experience. However, the design of the LANDING POOL along with associated water quality and circulation is regulated by this CODE.

4.12.2.4 Exit into Landing Pools

Present practices for safe entry into LANDING POOLS include:

- A water backup, and
- A deceleration distance.

4.12.2.9 Drop Slides

WATERSLIDES, particularly those that drop BATHERS into the water *(versus being delivered to a water entry point)*, from a height above the water require diligent MONITORING by staff at the top of the SLIDE and the water entry point to ensure there is adequate spacing between SLIDE users so that people do not land on top of each other. Each SLIDE user must have time to move out of the collision zone before another SLIDE user is allowed down the SLIDE.

4.12.2.9.1 Designed for Safety

Portable slides are prohibited, as their location is not fixed and the water depth, landing area, and clear spaces are not ensured.

4.12.3 Wave Pools

The WAVE POOL will still have side wall ladders for egress purposes *(and therefore partial trafficking)* and it was still felt that "No Diving" signage should still be required for all areas around the WAVE POOL regardless of water depth due to the freeboard.

4.12.4 Therapy Pools

4.12.5 Lazy Rivers

4.12.5.2 Access and Egress

4.12.5.2.1 Means

Since there is moving water in a LAZY RIVER, less frequent means of ingress/egress are acceptable. The moving water propels people around a LAZY RIVER quickly and with less effort to the next means of egress. LAZY RIVERS can be several hundred feet long. They are often constructed with side walls that make it difficult to exit the water. This distance will make it so that a BATHER will never be more than 75 feet *(22.9 m)* from an exit. The distance to the nearest exit for a large regular POOL can be as much as 50 feet *(15.2 m)*. This distance can be farther for a LAZY RIVER because of the current. If water is flowing at 1–4 feet/second

around the river, then a person floating around a river will never be more than 2.5 minutes from a means of egress.

4.12.5.2.2 Handhold

When BATHERS are required to be in or on a tube while in a LAZY RIVER, the SAFETY need for handholds is minimal *(shallow depth and slow current)* while the SAFETY deficits for such a requirement are increased. BATHERS on tubes holding onto a handhold can cause jams in the river, block the free flow of other guests, might cause BATHERS to be flipped out of tubes by jamming tubes together and could lead to aggressive action by those being blocked. An increased number of tubes in a small area will put additional and unnecessary pressure on lifeguards to control traffic and arbitrate disputes. Tube and raft congestion at entry/exit locations could impact lifeguarding, sight lines or rescue operations. It could impede entry points to a LAZY RIVER that would create crowd management and egress issues. It could create obstructions cited in MAHC 4.12.5.2.3.2. This could also make it much more difficult to spot and assist BATHERS who have fallen off a tube and require immediate help to get out from underneath the glut of tubes. In addition, handholds in a LAZY RIVER could also create the potential for injuries for BATHERS holding on from the opposing force of the water flow.

4.12.5.2.3 Deck

LAZY RIVERS are of necessity closed *(or mostly closed)* loops. The wall for the inside of a LAZY RIVER loop is an ISLAND which may be designed for people but is most often not. Therefore, a PERIMETER DECK is only needed for the outside of the river loop, or only on one side of the river.

4.12.5.2.4 Bridges

A 7-foot *(2.1 m)* minimum clearance overhead is required since it is consistent with requirements of building CODE minimum ceiling clearances. Most LAZY RIVERS are closer to 3.5 feet *(1.1 m)* deep making the clearance 7.5 feet *(2.3 m)* if you adhere to the 4 foot *(1.2 m)* clear requirement above the water surface. The MAHC chose 7 feet *(2.1 m)* because it is the typical building CODE minimum height requirement for ceilings whereas the 6 foot 8 inches *(2 m)* minimum clearance is usually only applicable to doorways.

4.12.6 Moveable Floors

4.12.6.3 Safety

4.12.6.3.1 Not Continuous

Examples of adequate SAFETY precautions for entering the other area of the AQUATIC VENUE include but are not limited to the following:

- A moveable BULKHEAD, located at least at the water surface, to enclose the area of the MOVEABLE FLOOR;
- A highly visible floating line installed over the MOVEABLE FLOOR surface, 2 feet *(61.0 cm)* in front of the end of the MOVEABLE FLOOR. A 4 inch *(10.2 cm)* wide contrasting marking shall be provided at this leading edge; and
- A railing system that shall be anchored into the MOVEABLE FLOOR.

4.12.6.3.2 Underside

When the MOVEABLE FLOOR is not continuous over the entire surface area of the POOL, access to the underside of the MOVEABLE FLOOR shall be denied when it is not flush with the POOL floor. Examples of adequate measures to prevent access under the MOVEABLE FLOOR include but are not limited to the following:

- Position a BULKHEAD at the end of the MOVEABLE FLOOR; and
- Have a trailing ramp that hinges to the MOVEABLE FLOOR and extends to the POOL floor.

4.12.6.4 Movement

There are no United States regulations on MOVEABLE FLOORS. This velocity was obtained from European design STANDARDS.

- European Standard EN 13451-11.

4.12.7 Bulkheads

4.12.7.2 Entrapment

All BULKHEAD parking positions should be designed such that QUALIFIED LIFEGUARDS can see under 100% of the BULKHEAD from their station on the POOL DECK.

4.12.7.5 Gap

BULKHEADS designed with greater gaps might result in BULKHEADS veering off its intended path.

4.12.7.6 Handhold

During WORLD AQUATICS sanctioned events, full height touchpads will be on most BULKHEADS. But most BULKHEADS in the United States allow for wide holes at the waterline for handholds and USA Swimming / NFHS / NCAA touchpads which are hung from these holes and are below the waterline. Touchpads aren't normally installed during normal operating hours. End wall concrete parapets that cantilever over the gutter that require full height WORLD AQUATICS touchpads for those level of competitions do not negate the requirement for handholds (though behind) in these locations.

4.12.7.9 Width

Any BULKHEAD that is intended for foot traffic for use by officials shall be at least 1 meter *(3 feet and 3 inches)* wide which is the current minimum width provided by commercial manufacturers.

4.12.7.9.1 Starting Platforms

Any BULKHEAD that dictates starting platforms shall be installed shall be at least 3 feet and 9 inches *(1.1 m)* wide to allow for sufficient trafficking space for officials and athletes behind the starting platforms.

4.12.8 Interactive Water Play Venues

Foot SHOWERS are recommended at the entry to the INTERACTIVE WATER PLAY AQUATIC VENUE to allow for rinsing debris from the PATRON's feet prior to entering. The use of FOOT BATHS is not an acceptable alternative and should be prohibited due to the potential for pathogen transmission between users. *See 4.10.6.* Wastewater from foot SHOWERS should be discharged to an approved waste disposal system to prevent standing water on the ground surface, and contamination of ground water, surface water or the INTERACTIVE WATER PLAY AQUATIC VENUE.

NON-RECIRCULATED INTERACTIVE WATER PLAY AQUATIC VENUES are commonly known as single pass splashpads, single use splashpads, or flow through splashpads. They are a type of INTERACTIVE WATER PLAY AQUATIC VENUE that does not recirculate water for filtration or disinfection. They instead use water from an approved source only once through spray features, and the water gets disposed of typically through a direct-to-waste drain(s) to a sewer system. Single Pass Splash Pads pose the same safety risks as INTERACTIVE WATER PLAY AQUATIC VENUE that recirculate water in terms of slipping, tripping, pinching, spray force hazards, and so on. Unique challenges associated with Single Pass Splash Pads arise from the fact that there is no on-site water treatment system. Depending on the water system used, the source water may or may not contain low-level residual disinfectant. However, these low levels of disinfectant in source water are not adequate to prevent biofilm-associated pathogens from growing if the water remains stagnant within the plumbing system of the AQUATIC VENUE. Pathogens that could grow and are of concern, if these facilities are not designed and operated properly, include but are not limited to: *Legionella*, *Pseudomonas aeruginosa, and Naegleria fowleri*. To ensure that water does not remain stagnant and does not allow pathogens to grow, the plumbing design including spray features, spray feature piping, and spray feature reservoirs, shall be so designed to allow water to be completely drained out when the AQUATIC VENUE is not in operation. The design shall also allow the entire plumbing system to be flushed out prior to each operation, to control biofilm growth (and prevent colonization with biofilm-associated pathogens) within the system. Moreover, it is important that the water is obtained from an approved potable water source, and the operator heeds any water quality advisories issued by the water treatment operator or AHJ.

4.12.8.3 Sloped

An example for an acceptable design solution would be a diverter valve installation.

4.12.8.6.5 Inlets

Proper sizing and positioning improves the filtration within the treatment tank by facilitating more complete mixing, providing for a uniform DISINFECTANT residual, and reducing areas where return water could settle and not get filtered.

4.12.8.10 Hazard

While consistent with many state CODES, the MAHC has determined that this topic needs more research regarding water velocity and eye SAFETY[221].

4.12.8.12 Signage

Since there is no standing water on interactive water play venues, depth markers and "No Diving" warning signs are not required. This was included because it deviates from the regular marking and warning signage requirements for typical AQUATIC VENUES as stated in this CODE. Other signage requirements such as diaper-changing reminders and "Do Not Drink" would likely be appropriate.

4.12.9 Wading Pools

4.12.9.2 Barrier

A more stringent requirement is stipulated for separating WADING POOLS from other AQUATIC VENUES *(compared with the spacing between other AQUATIC VENUES)* since the predominant users of WADING POOLS are small toddlers, most of whom cannot swim, and the inherent dangers posed by larger and deeper POOLS in close proximity.

4.12.9.2.2 Shallow Water

Rationale of 24 inches *(61.0 cm)* deep rule is that if adjacent water is not substantively deeper than the WADING POOL, there is no need to segregate them.

4.12.10 Other Aquatic Features

The industry continues to evolve with new AQUATIC FEATURES coming into the marketplace that are not yet specifically addressed in the MAHC or other CODES. Features such as climbing walls, inflatables, and play structures are now available for installation at AQUATIC FACILITIES. The intent of this section is to provide a basis for acceptance for installation and use of different AQUATIC FEATURES versus prohibition of installation and use of AQUATIC FEATURES not specifically identified/specified in the MAHC due to an absence of specific criteria. This allows an avenue to compliance until such a time that the MAHC is updated as appropriate with AQUATIC FEATURE specific criteria.

5.0 Aquatic Facility Operation and Maintenance

5.1 Operating Permits

5.1.1 Owner Responsibilities

5.1.2 Operating Permits

5.2 Inspections

5.2.1 Preoperational Inspections

5.2.2 Exemptions

5.2.3 Variances

The permit issuing official may waive, in writing, any of the requirements of this CODE, and include the variance as a condition of the permit to operate, when it reasonably appears that the public health and SAFETY will not be endangered by granting of such a variance and adequate alternative provisions have been made to protect the health and SAFETY of the BATHERS and the public. The burden of providing the data and proof that any alternative provision is at least as protective at the CODE requirement is entirely on the permit holder.

5.3 Equipment Standards

5.4 Aquatic Venue Operations and Facility Maintenance

5.4.1 Closure and Reopening

5.4.1.1 Closure

Short Closures

It is important for the QUALIFIED OPERATOR to be aware that when closed for even short periods of time, the AQUATIC VENUE water distribution system, including drinking fountains and other potable water sources, may become stagnated. It is important to adequately ensure that all AQUATIC FEATURES should be adequately flushed and disinfected prior to reopening. Standing water, including closed AQUATIC VENUES, can become a site for mosquito breeding if DISINFECTION is halted. Although mosquitoes can carry infectious pathogens such as those that cause dengue, malaria, and encephalitis, one of the most common mosquito-borne infections in the US is due to West Nile virus which can cause fever and encephalitis. One study demonstrated a link between abandoned residential swimming POOLS, increases in mosquitos, and West Nile virus infections[222]. Swimming POOLS should be disinfected to prevent them from becoming public nuisance issues, such as mosquito breeding sites. Additionally, closed POOLS can be a SAFETY concern, especially for small children. When the POOL is not drained or covered tightly to prevent entry, children may intentionally or accidentally enter the POOL and drown. Because of the slime that often builds on the wall of these abandoned POOLS, it might be impossible for those that enter the POOL to climb out. Abandoned POOLS might also have limited visibility so people falling in cannot be seen by other persons in the area. While fence ENCLOSURE or SAFETY covers can create a "safe condition" for the POOL, these methods will not prevent the potential mosquito problems mentioned above.

Long Closures

The closing of an AQUATIC FACILITY for less than 7 days is considered a temporary closure. A closure of more than 7 days is considered a long-term closure. Both types of closure require certain maintenance activities when closing or reopening to ensure a safe environment for PATRONS.

Drain / Cover

POOLS that use a cover should refer to ASTM F1346-91. For POOLS where covers are not used or are not practical, access should be restricted, and routine checking of fence integrity is advised.

ASTM F1346-91 establishes requirements for SAFETY covers for swimming POOLS, SPAS, hot tubs, and WADING POOLS. When correctly installed and used in accordance with the manufacturer's instructions, this

specification is intended to reduce the risk of drowning by inhibiting the access of children ages less than 5 years to the water. For long term and seasonal closures, where no residual DISINFECTANT is maintained in the pipes, further research is needed to understand the growth of biofilms during closure. More research is needed to develop protocols for removing biofilms in AQUATIC VENUES. If the AQUATIC VENUE system becomes non-operational, such as during a power outage, the AQUATIC VENUE should be cleared of BATHERS. Prior to reopening, the QUALIFIED OPERATOR should confirm that all systems are operational as required by the MAHC. For example, recoating DE filters will be necessary, and it should be confirmed that feed pumps did not continue feeding chemicals during a RECIRCULATION SYSTEM shutdown, as this could lead to outgassing into the POOL when the system is re-started.

5.4.1.2 Reopening

The QUALIFIED OPERATOR should refer to previous inspection reports for more details on repairs or replacements needed, and any replacements or new items should be discussed with the regulatory authority to verify they comply with current CODE requirements. It is recommended that a model reopening checklist be developed in the future.

5.4.2 Preventive Maintenance Plan

A preventive maintenance plan is a necessary and important part of any AQUATIC FACILITY operation based on data showing 22.8% of POOL chemical spills were due to equipment failure indicating they could have been prevented[206]. The best maintenance plan is one that follows the manufacturer's and POOL designer/engineer's recommendations for all equipment. A POOL maintenance plan is similar in many ways to the purchase of a new vehicle. With the purchase of a new vehicle, a manufacturer's maintenance schedule is included. The schedule lists the maintenance items that should be followed such as rotating tires and performing major tune-ups. Likewise, the QUALIFIED OPERATOR should perform an inventory of all equipment used in the AQUATIC FACILITY operation. For each piece of equipment, the QUALIFIED OPERATOR should develop a list and schedule of maintenance items. By following this maintenance schedule, the operator can help prevent costly repairs and breakdowns in the future. Replacing items before they breakdown might prevent system breakdowns that could lead to outbreaks or injuries. For example, a common breakdown leading to loss of DISINFECTION is a break in the tubing leading from feed pumps to the RECIRCULATION SYSTEM. Although inexpensive, lack of replacement has been implicated in outbreaks. AQUATIC FACILITIES need increased sophistication in plan maintenance and MONITORING.

5.4.2.2 Facility Documentation

This equipment inventory should contain information such as:

- Equipment name
- Manufacturer and contact information
- Local vendor/supplier & technical representative
- Model number
- Horsepower, GPM, & filter size
- Year of manufacture
- Original cost
- Warranty
- Operating Manual
- Equipment may be cataloged by area, such as:
- DECK
- Lifesaving
- HYGIENE FACILITY
- Filter System
- Concession Stand
- AQUATIC FEATURES

5.4.3 General Operations

5.5 Aquatic Venue Structure

5.5.1 Shape

5.5.2 Access Ladders

5.5.3 Color and Finish

5.5.4 Walls

5.5.5 Depth Markings

Existing AQUATIC FACILITIES should still adhere to the requirements of MAHC 4.5.19 for depth and NO DIVING MARKERS. Existing AQUATIC FACILITIES may have to resort to using non-permanent *(i.e., painted)* alternatives if not already installed, which will need to be maintained to ensure they are readable and legible.

5.5.6 Pool Shell Maintenance

These sections of the CODE require repairs related to health and SAFETY such as if the CRACKS could cause trips, falls, lacerations, trap dirt and debris, or harbor algae or bacteria. It is still good operational practice to identify and MONITOR CRACKS that could lead to water loss and structural failure and consult a structural engineer for assessment as needed.

CRACKS exhibiting any of the following characteristics shall be evaluated by a structural engineer:

- CRACKS with vertical displacement;
- CRACKS of varying width;
- CRACKS concentrated to a specific area;
- CRACKS exposing any reinforcement;
- CRACKS obviously recurring from previous patches;
- CRACKS in corners;
- CRACKS drawing a defined line; and
- Surface CRACKING over 1/8 inch *(3.2 mm)* in width.

5.6 Indoor / Outdoor Environment

5.6.1 Lighting

5.6.1.1 Lighting Maintained

5.6.1.1.1 Light Levels

System components will deteriorate and eventually need to be replaced, but lamp performance will continue to change prior to complete lamp failure. Indoor overhead lights, outdoor pole mounted lights, and underwater lighting are the key POOL light sources. Building lighting must also be maintained to provide safe AQUATIC FACILITY use, building and area security, and meet the aesthetic goals. Planned lighting maintenance includes group relamping, cleaning lamps, cleaning luminaires, and replacing defective components on a regular basis. Lamp lumen depreciation is a characteristic of all lamps. Each lamp type has a different lamp life, thus impacting your maintenance schedule. As lamps fail or burn out, the local light levels are decreased, and the lighting uniformity is also affected. Luminaire surface deterioration and dirt accumulation might also occur and can reduce the light reaching the needed areas. During relamping and cleaning, inspect each luminaire for deterioration or damage. Repair or replace components and inspect and clean light FIXTURES and luminaires as needed to maintain required light levels. Consider regular group relamping combined with cleaning as part of an efficient and effective maintenance plan.

Basic steps for cleaning and relamping operations include the following:

1. Turn off electrical circuits and carefully remove lenses, diffusers, shields or lamps.
2. Dispose of replaced lamps and ballasts per state and federal guidelines.
3. Contact the EPA for more information.

4. Follow the light FIXTURE and lamp manufacturer's recommendations for cleaning, relamping, and maintaining each light in good condition.
5. Routinely MONITOR underwater lights for proper operation.

Windows and natural lighting need to be evaluated seasonally and throughout the operating day.

Light levels might also be altered by dirty windows. Ensure that windows are cleaned regularly to eliminate any buildup of material that would affect light transmission.

5.6.1.1.2 Main Drain Visible

The requirement for being able to see the main drain from poolside is a SAFETY issue. If QUALIFIED LIFEGUARDS or QUALIFIED OPERATORS cannot see the main drain, then they are unable to see a person on the bottom of the AQUATIC VENUE and unable to initiate rescue procedures. This is cause for immediate closure and rectification before re-opening. Please refer to the MAHC 6.6.3 for more information. The section also clarifies that mixed use AQUATIC FACILITIES *(for example, AQUATIC FACILITIES with mechanical rides, catering facilities)* may host evening events where lighting does not allow main drains to be visible, but these AQUATIC VENUES must have ENCLOSURES and be closed to PATRON use.

5.6.1.1.3 Underwater Lighting

Recent high-profile electrocution incidents have highlighted the need to clarify underwater lighting requirements to prevent these incidents. A defect occurring in an electrical circuit operating at greater than the Low Voltage Contact Limit that is not GFCI protected can result in serious injury or an electrocution death of BATHERS.

5.6.1.2 Glare

In addition to discomfort, annoyance, interference, and eye fatigue, glare reduces the visibility of an object. Without clear vision, there are increased chances for accidents that can cause injuries or potential drowning. Glare can be from reflections as well as direct lighting problems.

5.6.1.2.1 Assessments

The AQUATIC FACILITY owner or LIFEGUARD SUPERVISOR may consider adjusting lifeguard positions to improve visibility.

5.6.1.2.1.1 Lifeguard Positions

The wording ensures that each lifeguard position as identified in the Zone of PATRON Surveillance is evaluated appropriately and includes roving positions since it is not limited to just those position which have a fixed stand or 'station'.

5.6.2 Indoor Aquatic Facility Ventilation

Drains on air-handling system equipment should be tested before the system is started. It is important that the drain system be checked regularly to ensure that the condensate drain pan, drain connection, and piping are free from buildup or blockages. In cases where air handling equipment is intended for use with P-trap type drains, the P-trap must be kept filled manually if normal operation does not keep the P-trap filled. If not kept filled, sewer gases, and odors can enter the system.

5.6.2.8 Combined Chlorine Reduction

Water chemistry affects air quality:

- The amount of DISINFECTANT in the water should always be at sufficient concentration to DISINFECT properly, but high residual concentrations in an indoor environment contribute to the development of DBPs. A higher ratio of CHLORINE to nitrogen content in the water results in the formation of TRICHLORAMINE. Lower concentrations of CHLORINE/bromine in the POOL results in lower concentrations of DBPs in the presence of organic and inorganic CONTAMINANTS.
- High residual concentrations have been a requirement for outdoor AQUATIC VENUES that have sunlight exposure, but that requirement may not be necessary for INDOOR AQUATIC FACILITIES.

- Free CHLORINE concentrations could likely be maintained at a lower concentration due to the absence of dechlorination due to sunlight.
- Lower pH increases the effectiveness of CHLORINE. By maintaining pH less than 7.5, less CHLORINE is required to achieve effective DISINFECTION[223].

The water quality will affect the air quality in INDOOR AQUATIC FACILITIES. Also, BATHER practices will determine not only the water quality but also the air quality. Therefore, if air handling equipment is installed, INDOOR AQUATIC FACILITY operators should develop and implement a program to operate, MONITOR, and maintain the equipment as designed to reduce COMBINED CHLORINE compounds introduced into the building from the AQUATIC FEATURES in accordance with the INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM design engineer or the AIR HANDLING SYSTEM equipment manufacturer's recommendations.

5.6.3 Indoor/Outdoor Aquatic Facility Electrical Systems and Components

5.6.3.1 Electrical Repairs

NEC Article 225 provides installation requirements for outside branch circuits and feeders that run on *(or between)* structures or poles. NEC Article 680 applies to the construction and installation of electrical wiring for and equipment in or adjacent to all swimming, wading, therapeutic, and decorative POOLS; fountains; hot tubs; SPAS; and hydro-massage bathtubs, whether permanently installed or storable, and to metallic auxiliary equipment, such as pumps, filters, and similar equipment.

5.6.3.2 Electrical Receptacles

NEC Article 680.22, "General Circuitry Pool Pump Motors," states that "all 15- and 20-amp, single-phase, 125-volt or 240-volt outlets supplying POOL pump motors shall have GFCI protection." 29 CFR 1910.304, "Wiring Design and Protection," applies to temporary wiring installations that are used during construction-like activities, including certain maintenance, remodeling, or repair activities, involving buildings, structures, or equipment.

5.6.3.3 Ground-Fault Circuit Interrupter

GFCI testing should follow the manufacturer's recommendations. However, the minimum test procedure should include:

a) Testing personnel must wear shoes during the entire test. Where exposed terminals are present, or where conditions warrant, other PPE may be required.
b) A suitable indicating test load should be connected to the circuit under test and remain so for the duration of the test.
c) Test personnel should press the "TEST" button on the GFCI device.
d) The test load should then be observed to have ceased operation due to loss of electrical power.
e) Test personnel should next press the "RESET" button on the GFCI device.
f) The test load should then be observed to have resumed operation.
g) Where any of the conditions specified in steps (b) through (f) fail, the GFCI circuit must then be inspected and tested. Replace the GFCI device as necessary.

Chemical-Free Storage

POOL chemicals, fertilizers, salt, oxidizing cleaning materials, and other CORROSIVE MATERIALS should not be stored in any INTERIOR SPACE containing electric light FIXTURES, panel boards, fuses, circuit breakers, disconnects, motors, motor overloads, bonding conductors, or similar devices.

- ***Exception (1):*** Otherwise approved chemical STORAGE areas having light FIXTURES which are approved for use in CORROSIVE atmospheres, and which serve the chemical STORAGE area only, should be acceptable.
- ***Exception (2):*** Otherwise approved chemical STORAGE areas having a light switch or switches approved for use in CORROSIVE atmospheres, and which serve the chemical STORAGE area only, should be acceptable.

- ***Exception (3):*** Otherwise approved chemical STORAGE area containing small motors and the associated controllers, such as those for exhaust-blowers and peristaltic pumps should be acceptable where such motor circuits are protected by GFCI.
- ***Exception (4):*** Otherwise approved chemical STORAGE area containing devices CERTIFIED, LISTED, AND LABELED for use in interior POOL-chemical STORAGE areas should be acceptable.
- ***Exception (5):*** Otherwise approved chemical STORAGE areas containing devices CERTIFIED, LISTED, AND LABELED for use in CORROSIVE atmospheres should be acceptable where approved by the AHJ.

Flammable liquids and flammable gases should not be stored in any INTERIOR SPACE containing electric light FIXTURES, panel boards, fuses, circuit breakers, disconnects, motors, motor overloads, bonding conductors, or similar devices, unless such devices comply with Article 500 of the NEC or with the applicable local, state, territorial, federal, and tribal laws.

POOL chemicals, acids, fertilizers, salt, oxidizing cleaning materials, and other CORROSIVE or oxidizing chemicals should not be stored in INTERIOR SPACES where electrical conduits enter or pass through the space.

- ***Exception (1):*** Otherwise approved CHEMICAL STORAGE SPACE into which conduits enter or pass through should be acceptable, where such conduits
  - Are sealed where they enter and exit the STORAGE space, and
  - Are listed as corrosion resistant, and
  - Serve only approved loads in the STORAGE space itself.
- ***Exception (2):*** Otherwise approved chemical STORAGE areas containing conduits approved for use in CORROSIVE atmospheres should be acceptable if approved by the AHJ.

Where an interior CHEMICAL STORAGE SPACE was previously approved for STORAGE of POOL chemicals, acids, fertilizers, salt, oxidizing cleaning materials, other CORROSIVE or oxidizing chemicals, or flammable liquids or gases and will continue to be used for such STORAGE, any replacement electrical parts or devices should be of the same type as the original equipment, or should be CERTIFIED, LISTED, AND LABELED for such use. No new electrical devices or equipment should be installed in an interior CHEMICAL STORAGE SPACE used for STORAGE of POOL chemicals, acids, fertilizers, salt, oxidizing cleaning materials, or flammable liquids or gases without re-inspection by the AHJ.

Isolation of Chemical Storage Areas

An interior STORAGE space used for storing POOL chemicals, fertilizers, salt, oxidizing cleaning materials, other CORROSIVE or oxidizing chemicals, or pesticides must be kept in isolation from other INTERIOR SPACES, except for entry, egress, material transport, or alarm testing. The period of each instance of entry, access, or alarm testing should not exceed 15 minutes. The sum of the periods of all instances of breach of isolation should not exceed 1 hour in each 24-hour period. Where the isolation of an interior STORAGE space containing such chemicals from other INTERIOR SPACES containing COMBUSTION DEVICES depends on an interior door, such door should be gasketed to prevent the passage of air, fumes, or vapors, and should be equipped with an automatic door closer and an alarm that will give notice if the door remains open for more than 5 minutes. Function of this alarm should be confirmed monthly as part of scheduled maintenance. Failures of door gasketing, or of the door closer, or of the alarm should be repaired immediately.

Unsealed Openings

Where any unsealed openings exist between an interior STORAGE space used for POOL chemicals, acids, fertilizers, salt, or CORROSIVE or oxidizing chemicals and any other INTERIOR SPACE containing electrical equipment, the air pressure in the CHEMICAL STORAGE SPACE should be maintained at a level low enough to ensure that all air flow should be toward the CHEMICAL STORAGE SPACE. This pressure difference should be maintained by a continuously operating exhaust system used for no other purpose than to remove air from the CHEMICAL STORAGE SPACE. Function of this exhaust system should be MONITORED continuously by a pressure switch and alarm. Function of the pressure switch and alarm should be confirmed monthly as part of scheduled maintenance. In the event of failure of the exhaust system or of the alarm, repairs should be done immediately. In any space containing electrical equipment, ambient conditions such as temperature, humidity, and maximum concentrations of chemical fumes or vapors, or of flammable fumes or vapors should be continuously MONITOR to meet the operational requirements of installed electrically powered equipment.

Labels or other marks indicating the circuits served by fuses, circuit breakers, and disconnect switches should be maintained in a condition readable by a person unfamiliar with the function of the circuits. For spaces containing fuses, circuit breakers, electric motors, or motor-operated loads, the recommended minimum illumination capability should be maintained as part of the scheduled monthly maintenance. STORAGE should not interfere with the largest of the minimum working clearances specified by the NEC, the equipment manufacturer, 29 CFR 1910 or by applicable local, state, territorial, federal, and tribal laws.

Re-lamping

Re-lamping operations within 20 feet *(6.1 m)* horizontally of the nearest inside edge of a POOL, SPA, FLUME, WATERSLIDE, or other open AQUATIC FEATURE should be carried out in such a way as to minimize the likelihood of lamp breakage. New lamps should be kept in their packing until just before installation. Old lamps should be packed immediately upon removal into a suitable container to prevent breakage. New lamps should not be stored in an interior STORAGE space used for POOL chemicals, fertilizers, salt, or other CORROSIVE or oxidizing chemicals. Neither new lamps nor old lamps should be stored in the INDOOR AQUATIC FACILITY, SHOWER room, locker room, or hallways. Where visible or accessible, any required bonding jumpers should be visually inspected for damage, breaks, looseness, or corrosion quarterly as part of scheduled maintenance. Where any doubt exists concerning the condition of bonding jumpers, they should be inspected and, if necessary, the effectiveness of such jumpers should be tested.

5.6.3.4 Grounding

The purpose and objective of NEC Article 250 - Grounding is to ensure that the electrical system is safe against electric shock and fires by limiting the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and a ground-fault *(line-to-case fault)*. The rules contained in NEC Article 250 identify the installation methods that must be followed to ensure a safe electrical installation. NEC Article 680 applies to the construction and installation of electrical wiring for and equipment in or adjacent to all swimming, wading, therapeutic, and decorative POOLS, SPAS, INTERACTIVE WATER PLAY AQUATIC VENUES, and hydromassage bathtubs *(whether permanently installed or storable)* and to metallic auxiliary equipment, such as pumps, filters, and similar equipment.

5.6.3.6 Extension Cords

5.6.3.6.3 Exception

The intent is to prevent the extension cord from reaching the water.

5.6.3.6.6 Compliance

See 29 CFR 1910.304 (b)(2) at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.304

5.6.3.8 Communication Devices and Dispatch Systems

NEC Article 800 covers multi-purpose and communication cable. Multi-purpose cable is the highest listing for a cable and can be used for communication, Class 2, Class 3, and power-limited fire protective cable. Communication cable can be used for Class 2 and Class 3 cable and also as a power-limited fire protective cable with restrictions.

5.6.4 Facility Heating

5.6.4.1 Facility Heating

5.6.4.1.1 Maintenance and Repair

There are several CODES which can be consulted. These include but are not limited to the NFPA 54, NEC, and certain building CODES.

5.6.4.1.2 Defects

If inspection shows excessive fouling of air filters before the cleaning or replacement period has ended, that period should be reduced to prevent overloading of filters. Filters that become clogged with dirt, mold, or other CONTAMINANTS can become a source of increased operating costs and poor air circulation. In addition

to the reduction of system effectiveness, which can result in costly repairs, airborne CONTAMINANTS can be spread as a result of improper air handling.

5.6.4.1.3 Temperature

The air temperature of an indoor AQUATIC VENUE should be controlled to the original specifications where possible. Where this is not possible, the air temperature of an INDOOR AQUATIC FACILITY should be controlled to prevent unexpectedly high levels of evaporation and to prevent condensation of water onto surfaces not designed for condensation. Particular care should be taken to prevent the condensation of water inside indoor AQUATIC VENUE building surfaces such as walls and ceilings. This CODE only looks at the part of the facility where the water "vessel" and supporting infrastructure *(e.g., equipment or pump room)* is located and not at other areas of buildings, which the building CODE would cover. Particular attention needs to be given to the prevention of algae and mold growth on surfaces.

5.6.5 First Aid Room

5.6.6 Emergency Exit

5.6.7 Plumbing

5.6.7.1 Water Supply

The potable water pressure should be maintained to enable the AQUATIC VENUE and all other water using PLUMBING FIXTURES to operate to design specifications.

5.6.7.3 Wastewater

In some AQUATIC FACILITIES, backwash water may be recycled for other purposes instead of wasted to conserve water. This water must be treated in accordance with local, state, territorial, federal, and tribal laws prior to being re-used. Backwash water is likely to be routinely contaminated with pathogens. So its use should be carefully considered, and health issues planned for prior to re-use. It should not be re-used in AQUATIC VENUES but may be used in landscaping or other non-potable water uses with AHJ approval.

5.6.7.4 Water Replenishment

See MAHC Annex Section 4.7.4 for more information. A minimum of 4 gallons *(15 L)* of water per BATHER per day must be discharged from the POOL, but a volume of 8 gallons *(30 L)* per BATHER per day is recommended. Backwash water will count toward the total recommended volume of water to be discharged, but evaporated water will not count since inorganic CONTAMINANTS *(e.g., salts and metals)* and many organic CONTAMINANTS *(e.g., sweat and urine)* can simply be concentrated as water evaporates. Backwash water or other discharged water may not be returned to the POOL without treatment to reduce the total organic carbon concentration, DBP concentrations, turbidity, and microbial concentrations to less than the limits set for tap water by the EPA.

5.6.8 Solid Waste

5.6.9 Decks

5.6.9.1 Food Preparation and Consumption

5.6.9.1.2 Eating and Drinking

Eating and drinking in AQUATIC VENUE areas may expose BATHERS to CONTAMINANTS. Food particles that fall into the POOL not only contribute to contamination burden but might also affect POOL DISINFECTION. Additionally, contamination can occur through ingestion. Alcohol increases urine output and therefore creates more chloramines and other DBPs if BATHERS do not regularly get out of the POOL to urinate. Regular bathroom breaks should be considered to reduce urination in an AQUATIC VENUE that allows designated areas like "swim-up bars" that might lead to increased POOL urination and create compliance issues with MAHC COMBINED CHLORINE concentrations. However, no data, suggesting that AQUATIC VENUES containing "swim-up bars" have any more issues with water quality compliance issues that those AQUATIC VENUES that do not, could be found. Owners/operators of AQUATIC VENUES considering "swim-up" bars need to be aware that these areas might also increase the risk of drowning caused by excessive alcohol consumption and should

include this thinking in lifeguard training and in-service training. Currently, most states do not allow swim-up bars; however, Ohio, Hawaii, Texas, and a few local jurisdictions do, mostly in resort areas. The MAHC defers to AHJs to assess and determine potential risks. The MAHC defers to AHJs to assess and determine potential risks. Another topic is nursing mothers and SAFETY and health risk to infants. CDC is not aware of any risks to other swimmers related to breastfeeding in pool or splash pad water. It is unlikely that breastfeeding in the water presents any more risks for babies and young children (0–4 years old) than the risks associated with regular pool or splash pad use for babies and young children. These risks include swallowing water, exposure to swimming-related illnesses, issues regulating body temperature, and drowning. Visit CDC's Healthy Swimming website for more information.

5.6.9.2 Glass

Glass is prohibited in the POOL DECK area to prevent injuries to PATRONS and staff. Most PATRONS can be barefoot, so stepping on glass can cause serious injuries. If a glass container breaks in the AQUATIC VENUE vicinity, it could potentially fall into the water. Clear glass is virtually invisible in water and is difficult to remove. The only way to ensure all broken glass is removed from AQUATIC VENUE water is to thoroughly drain, clean, and refill the structure. Depending on the size, draining and cleaning an AQUATIC VENUE can cost thousands of dollars.

5.6.9.3 Deck Maintenance

5.6.9.3.1 Free From Obstructions

DECKS should always be kept clear of obstructions to preserve space that could be needed for rescue efforts. Obstructions also cause tripping hazards and can lead to falls and serious injuries. Attention must also be given to potential fall hazards from slippery DECK areas.

5.6.9.3.3 Vermin

It is important to maintain these areas free from debris, vermin, and vermin harborage. Animals can carry diseases which could be transmitted through bites or contact with bodily fluids or feces.

5.6.9.3.4 Original Design

Proper maintenance of surfaces will help prevent abrasions to BATHERS and biofilm growth.[224]

5.6.9.3.4.1 Crack Repair

CRACKS in the DECK shall be part of the daily inspection process and be repaired when they might increase the potential for injury. See MAHC Code and 5.5.6, "Pool Shell Maintenance."

5.6.10 Aquatic Facility Maintenance

5.6.10.1 Diving Boards and Platforms

SLIP-RESISTANCE can be accomplished by ensuring that the coefficient of friction is greater than or equal to that specified in MAHC 4.8.1.4.

5.6.10.3 Starting Platforms

Starting blocks are designed for use by trained persons or those under the supervision of a qualified individual. Use by untrained, unsupervised individuals can lead to serious injury.

5.6.10.5 Fencing, Enclosures, and Barriers

This wording refers to alarms associated with open gates or ENCLOSURES. It is not meant to include burglar or fire alarms.

5.6.10.6 Aquatic Facility Cleaning

In-POOL cleaning systems must be periodically inspected to make sure they retract and stay flush with the floor.

5.7 Recirculation and Water Treatment

5.7.1 Recirculation Systems and Equipment

5.7.1.1 General

The MAHC does not allow shut down of the RECIRCULATION SYSTEM during closure times since uncirculated water would soon become stagnant and loose residual DISINFECTANT likely leading to biofilm proliferation in pipes and filters. This would likely compromise water quality and increase the risk to BATHERS. MAHC 4.7.1.10.5 describes turndown system design. The flow turndown system is intended to reduce energy consumption when AQUATIC VENUES are unoccupied without compromising water quality. A turbidity goal of less than 0.5 NTU has been chosen by a number of United States state CODES *(e.g., Florida)* as well as the PWTAG and WHO. The maximum turndown of 25% was selected to save energy while not necessarily compromising the ability of the RECIRCULATION SYSTEM to remove, treat, and return water to the center and other extremities of the POOL. Additional research in this area could identify innovative ways to optimize and improve this type of system and that more aggressive turndown rates are acceptable.

5.7.1.1.2 Water Clarity

See MAHC Annex sections 4.7.1.10.5 and 5.7.6 for more information.

5.7.1.1.3 Gutter / Skimmer Pools

The recommendation for gutter or SKIMMER POOLS with main drains to have the majority of the water *(at least 80% of the recommended recirculation flow)* be drawn through the perimeter overflow system and no greater than 20% through the main drain during normal operation is based on subsurface distribution of bacteria data that showed most POOLS had higher surface concentrations of bacteria.[225] For the 65 POOLS examined, surface concentrations of bacteria were an average of 3.4 times greater at the surface. However, about 30% of the POOLS showed the opposite trend with higher subsurface concentrations, which is why some operational flexibility is provided with these values. For reverse flow *(upflow)* POOLS, 100% of the recommended circulation flow should be through the perimeter overflow system, which is consistent with the German DIN Standards[116]. Efficient removal of surface water is critical for maintaining water quality because surface water contains the highest concentration of pollutants from body oils, sunscreens, as well as other chemicals or particles that are less dense than water. Bacteria appear to follow the same trend in most cases[225]. The distribution of CHLORINE-tolerant pathogens like *Cryptosporidium* is not known at present. Most of the organic pollution and contamination is concentrated at or near the surface irrespective of the mixing effects of the circulation.

5.7.1.3 Inlets

During regular seasonal operation following initial adjustments, INLETS should be checked at least weekly so that the rate and direction of flow through each INLET has not been changed substantially from the original conditions that established a uniform distribution pattern and facilitated the maintenance of a uniform DISINFECTANT residual throughout the entire facility without the existence of dead spots. A tracer test *(e.g., with a sodium chloride tracer injected on the suction side of the pump)* should be conducted annually at startup and documented to quantitatively assess distribution pattern in the POOL. An amount of salt sufficient to increase the baseline conductivity by at least 20% should be added over a 1-minute period, and the conductivity or TDS should be measured at 1-minute intervals until the conductivity increases by 20% or stops changing for ten consecutive readings after an initial increase. Samples may also be taken at the corners, center, and bottom of the POOL *(via a sample pump with the POOL unoccupied)* in small, labeled containers for later measurement to increase the amount of information available to assist in interpreting the results. Increases greater than predicted by the amount of salt added to the POOL volume indicate poor mixing. Areas with conductivities lower than in the return stream at the time the sample was collected are likely to be areas with poor recirculation flows.

Note: It is possible to do a tracer test, which is quantifiable in terms of salt concentration ratios or time required to reach equilibrium concentration near the filter.

5.7.1.6 Piping

Winterization might involve dropping the water level below the level of the INLETS, blowing or draining all the water out of the pipes, adding antifreeze, and closing off both ends. Pipes should be drained or winterized

in regions where freezing temperatures are expected to be reached inside of the pipes. This should not be done with car antifreeze, and the antifreeze should not be toxic to humans.

5.7.1.8 Flow Meters

Flow meters are important for the maintenance of proper filtration, backwashing, and recirculation flow rates. It is also feasible to save money on electrical costs by using the flow meter to MONITOR and adjust the speed of the pump.

5.7.2 Filtration

5.7.2.2 Granular Media Filters

5.7.2.2.4 Backwashing Frequency

Backwashing frequency is important for multiple reasons. First, solids attach more strongly to the filter media over time and can be more difficult to remove following infrequent backwashing. Secondly, the organic particles *(e.g., skin cells)* held in the filter in contact with free CHLORINE can break down over time and produce DBPs or COMBINED CHLORINE. The potential to form "mudballs" also increases with solids loading inside of a filter and can cause filter failures. The preceding items are the rationale for requiring backwashes at manufacturer-prescribed pressure losses through the filter. Some data suggests tainted backwash water remains inside of the filter at the conclusion of the backwash procedure and therefore should be wasted to drain for at least the first 2 minutes after restarting.

5.7.2.2.4.1 Backwash Scheduling

Backwashing while PATRONS are in the water is not recommended. First, the MAHC requires that RECIRCULATION SYSTEMS are running at all times that an AQUATIC VENUE is open for BATHER use. Second, with no interlock in place, stopping recirculation while inadvertently continuing chemical feed pumps can cause a build-up of acid and CHLORINE product in the lines that leads to CHLORINE gas production. When the RECIRCULATION SYSTEM is turned back on, the risk increases dramatically for a CHLORINE gas plume being delivered into the AQUATIC VENUE causing injury to BATHERS and initiating an emergency response[159, 160]. As a result, there have been frequent occurrences of CHLORINE gas exposure following the restart of the recirculation pump while BATHERS are in the AQUATIC VENUE. This underscores the need for BATHER evacuation of the AQUATIC VENUE prior to restart of recirculation and waiting 5 minutes to check for potential gas release before allowing BATHERS into the water, to prevent potential exposure to CHLORINE gas. Exceptions to this would be if an AQUATIC VENUE has multiple filters and an individual filter can be taken offline without shutting down the RECIRCULATION SYSTEM and there is no chance of overfeeding chemicals that might lead to outgassing events or other chemical mixing emergencies.

5.7.2.2.7 Filtration Enhancing Products

Coagulants should be used with caution due to potential for filter bed fouling. Maintaining records of clean bed head loss is recommended to help detect problems of filters not being adequately cleaned via backwashing. If a facility decides to use coagulants, they should be used continuously. Not using coagulants when the water is clear to save money will substantially impair the capabilities of the filters to remove pathogens like *Cryptosporidium* and *Giardia*.

5.7.2.3 Precoat Filters

5.7.2.3.2 Return to the Aquatic Venue

In closed-loop mode, it will be necessary to charge the media slurry to the suction side of the pump or precoat tank, prior to closing down the loop and putting the system into recirculation. Precoating of a filter typically takes 5–10 minutes. At the end of the precoat cycle, the discharge out of the filter should be clear and free of filter media. If the discharge is not clear, the filter should be opened, inspected, and repaired as necessary.

5.7.2.3.3 Operation

When flow or pressure is lost in the filter, the precoat layer might become unstable and fall off the filter septum. To reduce the likelihood of debris and CONTAMINANTS being returned to the AQUATIC VENUE, it is recommended that prior to restarting the filter, it should be backwashed or cleaned and the precoat re-

established with new filter media in a closed loop recirculation mode or with water wasting until the discharge of the filter is clear to minimize the potential of media or debris re-entering to the AQUATIC VENUE. It is important that flow not be interrupted after the precoating process is completed and the flow out of the filter is redirected from the recirculation or waste piping back to the AQUATIC VENUE. It is acceptable to open and close valves on the filter effluent stream as long as the closed valves are opened first so that the filter effluent water can flow continuously. Allowing the media to fall off the filter septum decreases the capability of the filter to remove particles. The critical importance of always cleaning the filter and replacing the media when the flow is interrupted for any reason is related to uneven recoating permitting pathogen passage as well as fouling of the media support layers.[146]

5.7.2.3.4 Cleaning

Septum covers should be properly cleaned and inspected to maintain proper performance of precoat filters. Filters should be backwashed following a substantial drop in the flow rate or when the pressure differential across the filter is greater than 10 psi *(69.90 KPa)*. Vacuum–type precoat filters should be cleaned when the vacuum gauge reading increases to greater than 8 inches *(20.3 cm)* of mercury or as recommended by the manufacturer. If after precoating with fresh media, the filter pressure does not return to the normal initial starting pressure noted on filter start-up, it would be advisable to disassemble the filter and clean the elements *(septum covers)* per the filter manual. Septum covers should be cleaned or replaced when they no longer provide effective filtration or create a friction loss preventing maintenance of the recommended recirculation rate. Water and spent media should be discharged in a manner approved by the appropriate regulatory agency.

5.7.2.3.6 Bumping

Bumping is the act of intentionally stopping the filter and forcing the precoat media and collected CONTAMINANTS to be removed from the filter septum. Bumping might impair pathogen removal and could facilitate the release of pathogens previously trapped in the filter. Therefore, bumping should be performed in accordance with the manufacturer's recommendations. Prior to restarting a bumped filter, it is recommended that the precoat be re-established in a closed loop recirculation mode or with water wasting until the discharge of the filter is clear to minimize the potential of media or CONTAMINANTS to re-enter the AQUATIC VENUE. Pending future research, bumping is strongly discouraged in any precoat filter application where pathogen removal is a concern. Bumping might impair pathogen removal as pathogens once trapped at the surface of the cake could be re-positioned close to the septum and penetrate the filter during operation.[137] Cyst-contaminated water used for precoating filters led to much higher cyst concentrations in the filter effluent.[135] Precoat filters have been demonstrated to remove greater than 99% of the OOCYSTS. Using clean precoat media to precoat filters as well as maintaining continuous flow is recommended.[134, 135, 146]

5.7.2.3.7 Filter Media

Continuous filter media feed *(or body-feed)* can be used to increase the permeability of the cake, maintain flow, and extend cycle length as it becomes coated with debris. Body-feed is filter media added during the normal filtration mode on a continuous basis. The amount of body-feed used is dependent upon the solids loading in the AQUATIC VENUE. Turbidity is the best available method to quantify and estimate solids loading. For filter influent turbidities greater than 1.5 NTU, body-feed might be beneficial with addition rates, ranging 1.0–4.0 ounces of DE per square foot of filter area per day dependent on the solids loading in the AQUATIC VENUE. The lowest effective concentration of suspension should be used in a body-feed system. The concentration of the suspension may not exceed 5% by weight. The body-feed system head and lines should be flushed once every 15 minutes for at least 1 minute to ensure proper and continuous operation. Water from the discharge side of the recirculation pump may be used. If connection is to a potable water supply line, the supply line should be equipped with an approved BACKFLOW prevention device.

Precoat media should normally be fed into the filter at a concentration not to exceed 5% by weight. Since perlite is approximately half the density of DE, half of the weight of perlite will achieve a similar depth of media inside of the filter as shown in MAHC Annex Table 5.7.2.3.7.1.

Table 5.7.2.3.7.1: Required Use Rates for Precoat Media

Media Type	Amount	Approximate Precoat Depth
DE	1.0 – 2.0 lb/10 ft^2 *(453.59 – 907.18 g/0.93 m^2)*	1/16 – 1/8 inch *(1.59 mm – 3.18 mm)*
Perlite	0.5 – 1.0 lb/10 ft^2 *(226.80 – 453.59 g/0.93 m^2)*	1/16 – 1/8 inch *(1.59 mm – 3.18 mm)*

5.7.2.3.7.1 Diatomaceous Earth

Drinking water applications typically recommend using DE at application rates of 0.2 pounds per square foot *(1 kg/m^2)*.[146] This practice seems to be based on research showing that the removal of 9-micron (*Giardia*-sized) microspheres increased from greater than 99% to greater than 99.9% as the precoat amount increased from 0.5 to 1 Kg/m^2.[134] Under the range of conditions tested, Logsdon and coworkers[137] found that the amount of DE had a greater impact on microsphere removal than did the grade of DE.

Alum-coated DE has been shown to significantly improve the removal of turbidity and bacteria not normally removed by DE filters.[153] Logsdon[150] reported that alum could be added at 0.05 gram of alum as $Al_2(SO_4)3 \cdot 14\ H_2O$ per 1 gram of DE in a slurry to form a precipitate on the surface to enhance performance.

5.7.2.4 Cartridge Filters

5.7.2.4.1 NSF Standards

Cartridge filter elements should be cleaned *(or replaced)* when the differential pressure across the filter exceeds 10 psi *(68.9 KPa)*. Every cartridge filter should have two sets of cartridges. This will allow for one set to be in use while the other is being cleaned *(soaking and drying are recommended)*.

5.7.2.4.2 Filtration Rates

The 0.375 GPM/ft^2 *(0.26 L/s/m^2)* maximum design flow rate is acceptable, but an allowance is necessary to accommodate irreversible fouling of cartridges *(i.e., cartridges that do not recover 100% of the original capacity when cleaned after fouling)*. Systems designed for a given TURNOVER TIME with a filter flow rate of 0.375 GPM/ft^2 *(0.26 L/s/m^2)* would not be in compliance if partially fouled cartridges dropped the flow rate to 0.30 GPM/ft^2 *(0.20 L/s/m^2)*. Therefore, an acceptable operating range is provided beyond which cartridge replacement would be necessary.

5.7.2.4.3 Filter Elements

Cartridges should be cleaned when the gauge pressure differential is 10 psi *(68.9 KPa)* and in accordance with manufacturer's instructions. Cleaning equipment should include a soaking container properly sized to immerse the filter elements, a rinsing area with proper drainage, and a drying area protected from contamination *(e.g., birds and insects)*. New filters do not regain 100% of their capacity. Perhaps only about 80% of the capacity is recoverable, regardless of the treatment. If the recommended design flow rate exceeds 80% of the maximum flow allowed on the filter, the filter may be undersized.

5.7.2.4.3.1 Cleaning Procedure

Facilities with cartridge filters are recommended to have the equipment onsite to clean the cartridges. This includes a basin or tub large enough to immerse the entire cartridge. Water from the cleaning and soaking process must be discharged to the sanitary sewer. Proper cleaning is critical. Failure to clean the cartridge properly can lead to disease outbreaks.

How to Clean Cartridge Filters:

1) RINSE THOROUGHLY: Rinse the cartridge of as much dirt and debris as possible by washing inside and out with a garden hose and spray nozzle.

- ***DO NOT*** use a pressure washer. High flow/pressure can drive the dirt into the interior and permanently damage the cartridge. It can also aerosolize pathogens in filter.[155]

2) DEGREASE: Cartridge filters need to be degreased each time they are cleaned. Body oil, suntan oil, cosmetics, hair products, or algae and biofilms can form a greasy coating on the filter pleats, which will clog the pores and reduce the filter capacity.

- Soak the cartridge overnight in:
  - Filter cleaner/degreaser, or
  - A solution of water with 1 cup *(236.6 g)* of TSP *(tri-sodium phosphate)*, or
  - One cup *(236.6 g)* of automatic dishwashing detergent per 5 gallons *(19 L)* of water.
- **Never use muriatic acid or products with acid in them prior to degreasing. Acid might permanently set the grease and ruin the cartridge.**

3) RINSE THOROUGHLY

4) SANITIZE: To remove or prevent biofilms, algae, and bacteria growing on the cartridge, add 1 quart *(0.95 L)* of household bleach per 5 gallons *(19 L)* of clean water and soak 1 hour before rinsing.

5) RINSE: Remove the clean cartridge from the sanitization soak water and rinse thoroughly with a hose.

6) DRY: After the filter is cleaned and degreased, it should be allowed to dry completely. Some bacteria (e.g., *Legionella* spp.) that survive the cleaning process can be killed by drying. Do not allow the filter to become contaminated with dirt or soil after it is cleaned. Put the cartridges in a clean plastic trash bag if they are to be transported and the original boxes are not available.

7) ACID WASH – ONLY IF NECESSARY: Excessive calcium or mineral deposits on the filter media can be cleaned with a 1:20 solution of clean water and muriatic acid. Put a few drops of muriatic acid on the filter. If it foams, it might need to be acid washed. Very few filters need to be acid washed.

5.7.2.4.3.3.2 Pressure Washer

A pressure washer should not be used because high flow/pressure can drive the dirt into the interior and permanently damage the cartridge or can aerosolize pathogens in the filter biofilm, which expose and infect workers when cleaning the cartridge filters in an enclosed space.[155]

5.7.3 Water Treatment Chemicals and Systems

Certification, listing, and labeling is required to ensure chemicals used in recreational water treatment have been evaluated including analysis for potential CONTAMINANTS of the product.

5.7.3.1 Primary Disinfectants

5.7.3.1.1 Chlorine (Hypochlorites)

Although CHLORINE and bromine are the only primary DISINFECTANTS allowed at this time, future research may produce other acceptable primary DISINFECTANTS.

5.7.3.1.1.2 Minimum DPD-FC Concentrations

It is necessary to ensure that DPD-FC is maintained at or above the 1.0 ppm *(mg/L)* minimum concentration at all times and in all areas of the POOL. Because CHLORINE efficacy is reduced in the presence of CYA, higher DPD-FC concentrations are necessary for POOLS using CYA or stabilized CHLORINE.

The minimum DPD-FC concentration of 1.0 ppm *(mg/L)* for swimming POOLS is well-supported by available data. Data indicate that a 1.0 ppm *(mg/L)* DPD-FC residual can provide effective DISINFECTION of most pathogens; *Cryptosporidium* is an exception.[226]

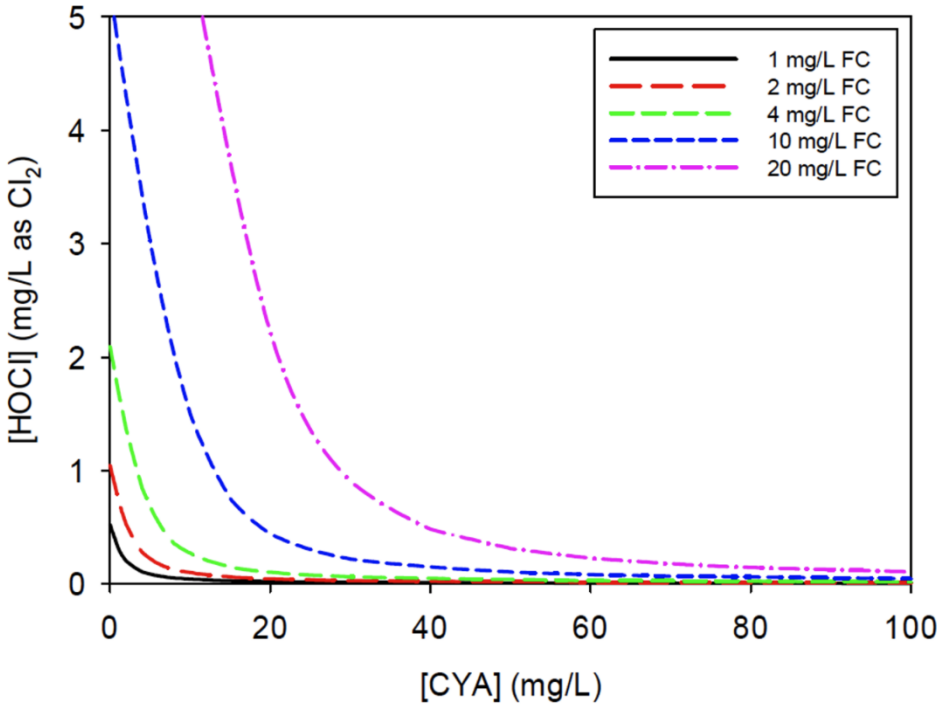
Table 5.7.3.1.1.2(a): Germ Inactivation of Chlorinated Water

Germ	Time
E. coli O157:H7 Bacterium[227]	Less than 1 minute
Hepatitis A Virus[228]	5-20 minutes
Giardia Protozoan*[229]	About 45 minutes
Cryptosporidium Protozoan*[127, 128]	About 15,300 minutes *(10.6 days)*

**Laboratory testing results using CHLORINE demand free water with 1 ppm (mg/L) CHLORINE at pH 7.5, 77°F (25 °C) and in the absence of cyanuric acid.*

Substantial laboratory data shows that inactivation times for microbial CONTAMINANTS are increased in the presence of CYA. However, there are a limited number of studies examining the impacts on CT INACTIVATION VALUES under AQUATIC VENUE conditions. For example, MAHC Annex Section 6.5.3.2 discusses CYA impact on *Cryptosporidium* inactivation when conducting a diarrheal fecal incident response. In real-world AQUATIC VENUES, the measurement of hydrochlorous acid *(HOCl)* concentration might be complicated by additional constituents that might be present in the water. Laboratory studies, from which CT INACTIVATION VALUES are derived, might not represent the complicated matrix *(e.g., pathogen clumping)* in AQUATIC VENUES that could influence pathogen inactivation rates based on HOCl. The impact on CT INACTIVATION VALUES is mostly related to the HOCl concentration that can be calculated using equilibrium constants for CYA and the chlorinated isocyanurates.

FIGURE 5.7.3.1.1.2(b): Impact of CYA on HOCl concentration. The curves were calculated using pH 7.5, 77°F/25°C, and 1,000 ppm TDS.[230]



In general, studies show that the presence of CYA increases DPD-FC CT INACTIVATION VALUES , and the amount of this increase depends upon the pH and the ratio of CYA to DPD-FC. As shown in the graph, at lower CYA: DPD-FC ratios *(up to about 10)* the HOCl concentration and therefore the inactivation rate changes rapidly as the CYA: DPD-FC ratio increases; the HOCl concentration and inactivation rate change less rapidly as the CYA: DPD-FC ratio increases above a ratio of 10. Studies suggest that CYA does not have the same effect on the DISINFECTION rate of monochloramine which, although a weaker DISINFECTANT than HOCl, remains unbound to CYA[231].

While the HOCl concentration is not currently measured by test kits and most sensors, its concentration is fairly consistent at constant CYA:DPD-FC ratios as shown in the tables below *(shown at 77°F/25°C)*, with all values in mg/L *(or ppm)* and DPD-FC and HOCl values as mg/L Cl_2.[230]

Table 5.7.3.1.1.2(c) HOCl concentration variation with CYA: DPD-FC ratio

CYA:DPD-FC=100:1

CYA	DPD-FC	HOCL
20	0.2	0.0037
30	0.3	0.0037
40	0.4	0.0038
50	0.5	0.0038
60	0.6	0.0038
70	0.7	0.0038
80	0.8	0.0038
90	0.9	0.0038

CYA:DPD-FC=20:1

CYA	DPD-FC	HOCL
20	1.0	0.020
30	1.5	0.020
40	2.0	0.020
50	2.5	0.020
60	3.0	0.020
70	3.5	0.020
80	4.0	0.020
90	4.5	0.020

CYA:DPD-FC=70:1

CYA	DPD-FC	HOCL
20	0.29	0.0053
30	0.43	0.0054
40	0.57	0.0054
50	0.71	0.0055
60	0.86	0.0055
70	1.00	0.0055
80	1.14	0.0055
90	1.29	0.0055

CYA:DPD-FC=10:1

CYA	DPD-FC	HOCL
20	2.0	0.042
30	3.0	0.043
40	4.0	0.043
50	5.0	0.044
60	6.0	0.044
70	7.0	0.044
80	8.0	0.044
90	9.0	0.044

CYA:DPD-FC=40:1

CYA	DPD-FC	HOCL
20	0.50	0.0095
30	0.75	0.0096
40	1.00	0.0097
50	1.25	0.0097
60	1.50	0.0097
70	1.75	0.0098
80	2.00	0.0098
90	2.25	0.0098

CYA:DPD-FC=5:1

CYA	DPD-FC	HOCL
20	4.0	0.099
30	6.0	0.10
40	8.0	0.10
50	10.0	0.10
60	12.0	0.10
70	14.0	0.10
80	16.0	0.10
90	18.0	0.10

By contrast, operating on the basis of a given minimum DPD-FC *(vs. A CYA:DPD-FC ratio)* leads to a broad range of HOCl concentrations as shown below *(with and without CYA)*.[230]

Table 5.7.3.1.1.2(d) HOCl concentration variations within MAHC limits for DPD-FC and CYA.

Current Min DPD-FC CYA	Current Min DPD-FC DPD-FC	Current Min HOCL
0	1.0	0.49
20	2.0	0.042
30	2.0	0.027
40	2.0	0.020
50	2.0	0.016
60	2.0	0.013

Current Min DPD-FC CYA	Current Min DPD-FC DPD-FC	Current Min HOCL
70	2.0	0.011
80	2.0	0.0098
90	2.0	0.0087

Swimming POOL survey data demonstrates that 1.0 ppm *(mg/L)* DPD-FC provides acceptable bacteriological quality[232]. However, another paper suggests that free CHLORINE concentrations significantly higher than 1.0 ppm *(mg/L)* might be required. Based on data collected from seven chlorinated POOLS, Ibarluzea et al. predicted that 2.6 ppm *(mg/L)* is needed "to guarantee, with a probability of 90%, the acceptability of bathing water at indoor chlorinated swimming POOLS."[233] A minimum DPD-FC concentration *(3.0 ppm [mg/L])* for SPAS addresses the relatively higher THEORETICAL PEAK OCCUPANCY, higher temperatures, or at-risk populations served by these venues. The THEORETICAL PEAK OCCUPANCY and temperatures of these venues favor microbial growth and can lead to rapid depletion of CHLORINE. This minimum requirement is consistent with CDC recommendations to minimize transmission of *Legionella* via whirlpool SPAS on cruise ships, published in 1997, which recommends maintaining free residual CHLORINE concentrations in SPA water at 3–10 ppm *(mg/L)*. It is further supported by a study reviewing both bromine and CHLORINE, which states, *Pseudomonas aeruginosa* was rapidly reestablished in SPAS *(greater than 103 cells per mL)* when DISINFECTANT concentrations decreased below recommended concentrations *(CHLORINE, 3.0 ppm [mg/L], bromine 6.0 ppm [mg/L])*.[187] In general, a range of 2–4 ppm *(mg/L)* DPD-FC for POOLS *(3–5 ppm (mg/L) for SPAS)* is recommended to help ensure the minimum DPD-FC concentration is maintained and to provide a margin of SAFETY for BATHERS.

For individual POOLS, considerations for ideal DPD-FC concentrations include:

- ***CHLORINE demand:*** DPD-FC concentrations should be sufficient to accommodate peak BATHER loads and other sources of contamination.
- ***Temperature and sunlight:*** DPD-FC concentrations should be sufficient to accommodate loss of DPD-FC from higher water temperatures and sunlight. The addition of stabilizer, either from stabilized CHLORINE or by itself, might be used to help minimize this loss of DPD-FC resulting from sunlight and volatilization of the DPD-FC at higher temperatures.
- ***Cyanuric acid:*** Because DPD-FC efficacy is reduced in the presence of CYA, the DPD-FC concentrations should be increased proportionally as the CYA concentration rises to provide consistent HOCl concentrations for DISINFECTION of POOLS using CYA or stabilized CHLORINE.[230, 231, 234-236]
- ***Algae control:*** Algae are more difficult to control than most bacteria and viruses and might require increasing DPD-FC residuals or decreasing the CYA:DPD-FC ratio, depending on other variables such as environmental factors *(e.g., sunlight or proximity to lakes or rivers)*, contamination with nitrates and phosphates, temperature, as well as the use of other POOL chemicals such as algicides, although peer-reviewed data is lacking.
- ***Accuracy of DPD-FC tests:*** POOL test kits are available with a range of accuracy as defined in NSF-50.
- ***Feeder equipment:*** Automated feeders help reduce variability in dosing and the potential for DPD-FC concentrations to fall below minimum concentrations.
- ***Feeder equipment sizing / TURNOVER RATE / circulation:*** A higher DPD-FC concentration might be needed when the feeder equipment sizing, TURNOVER RATE and circulation are not sufficient to ensure a minimum residual is maintained during spikes of CHLORINE demand.
- ***SECONDARY DISINFECTION:*** While the minimum DPD-FC concentration must be maintained in all AQUATIC VENUES, approved SECONDARY TREATMENT such as UV and ozone reduce risks from CHLORINE-tolerant pathogens. The relationship between SECONDARY TREATMENT and CHLORINE demand is complex. Both UV and ozone can destroy free CHLORINE. UV and ozone can react with CONTAMINANTS to reduce CHLORINE demand, but some reaction products from UV and ozone degradation might also react with CHLORINE. The balance among all these competing reactions as it

pertains to UV usually results in increased CHLORINE demand. For ozone, the balance among these potential reactions usually results in lower CHLORINE demand in high BATHER–load AQUATIC VENUES and higher CHLORINE demand in low BATHER-load AQUATIC VENUES, although scientific, peer-reviewed data are lacking.[237, 238] .

5.7.3.1.1.5 Maximum DPD-FC Concentrations

DPD-FC concentrations should be consistent with label instructions of the DISINFECTANT. All AQUATIC VENUE DISINFECTANTS must be registered by the EPA under FIFRA. The MAHC welcomes input and supporting data for establishing upper limits. Currently, the MAHC requires maximum DPD-FC concentrations to be consistent with label instructions. At present, product label instructions might use the terms free CHLORINE, FREE AVAILABLE CHLORINE, FC, or FAC in place of the term DPD-FC. An upper limit of 10 ppm *(mg/L)* has been chosen to ensure operators can still reasonably measure DPD-FC. Issues have arisen with extremely high concentrations being added when operators cannot measure DPD-FC and continue adding DISINFECTANT without realizing the test is bleaching out rapidly *(See MAHC Annex Section 4.7.3.5 for more information)*. EPA has not approved any POOL product use above 4 ppm *(mg/L)* DPD-FC or SPA product use above 5 ppm *(mg/L)* DPD-FC when BATHERS are present. The maximum DPD-FC concentration approved for POOLS is consistent with EPA's Maximum Residual Disinfectant Level *(MRDL)* of 4 ppm *(mg/L)* for drinking water. No data were identified suggesting health risks from DPD-FC concentrations at, or even substantially above, these concentrations. The EPA MRDL and the World Health Organization's drinking water guideline value for CHLORINE *(5 ppm (mg/L))* are based on drinking water studies that found no adverse effects related to CHLORINE[239]. Use of high concentrations of CHLORINE as a "shock dose" when BATHERS are not present may be part of an overall water quality management strategy. Periodic shock dosing can be an effective tool to maintain microbial quality of water and to minimize build-up of biofilms and inorganic chloramines. For BATHER re-entry, DPD-FC concentrations shall be consistent with label instructions of the DISINFECTANT. Salt water *(saline)* chlorination systems generate and deliver a CHLORINE DISINFECTANT onsite directly into POOL water. While cell size and configuration of these systems might differ depending on the manufacturer, the principles of their operation remain the same. Sodium chloride is added to balanced POOL water to establish a saline solution, which flows through the electrolytic cell. A low voltage electrical charge is passed through the saline solution and the current breaks the sodium and chloride bonds resulting in the formation of CHLORINE gas, hydrogen gas, and sodium hydroxide:

$$2\ H_20 + 2\ NaCl\ (aq) = Cl_2\ (g) + H_2\ (g) + 2\ NaOH$$

The hydrogen gas is dissolved in the water and eventually vents to the atmosphere. The CHLORINE gas then dissociates into HOCl, which provides a residual of FAC:

$$Cl_2\ (g) + H_20 = HOCl\ (aq) + HCl\ (aq)$$

Saltwater chlorination units should be sized appropriately to maintain minimum DPD-FC concentrations during maximum load periods. The units should ideally be controlled by an ORP controller. Operators must still test the DPD-FC concentration of the water to ensure that the cell is producing adequate CHLORINE for the POOL. However, a separate chlorinating product might be needed to provide a sufficiently high DPD-FC concentration for shock treatment or remediation following a fecal incident. MONITORING and maintaining the pH, total alkalinity, and TDS of the water in the POOL is important. Saltwater POOLS intentionally have high concentrations of sodium chloride. The sodium chloride will contribute to TDS but will not cause decreased DISINFECTANT efficacy or cloudy water. Electrolytic cells do wear out and need to be replaced. The life of the cell depends upon how many hours the cell operates each day, the pH of the water, and the calcium content of the water. The cells must be cleaned to remove scale build-up. The systems usually utilize reversal of the polarity on the cells to minimize the scale formation, but eventually the cell will have deposits that require the cell to be removed from the plumbing and soaked in an acid solution. The cells are also vulnerable to damage if they are operated in conditions of lower than recommended salt residuals or in water that is too cold. The systems have sensors and cut-offs to prevent this damage, but operators must be sure to MONITOR the unit to recognize when there is a problem.

5.7.3.1.2 Bromine

5.7.3.1.2.1 EPA Registered

The EPA Office of Pesticides registers products and approves labels for bromine. Currently bromine products on the market for use in recreational water are registered with use concentrations ranging from 1-8 ppm *(mg/L)*, depending on the product. The efficacy of these products has been studied by the manufacturers and submitted to the EPA under FIFRA. The efficacy data analyzed by the EPA is company confidential and has not been reviewed as part of the development of the MAHC.

5.7.3.1.2.2 Minimum Bromine Concentrations

Bromine concentrations established by state and local jurisdictions have not been found to correlate with data supporting the concentrations being used. However, every jurisdiction that allows bromine as a DISINFECTANT requires bromine at higher concentrations than CHLORINE and almost twice as much in SPAS and warmer POOLS. Commercially available test kits are not capable of distinguishing free bromine *(Br_2, HOBr, OBr-)* from combined bromine *(bromamines)*. The bromine value specified in test results is the concentration of TOTAL BROMINE, not the free available halogen that is tested with CHLORINE. To determine TOTAL BROMINE, test kit manufacturers use a CHLORINE value and multiply it by 2.25. The 2.25 conversion factor accounts for the molecular weight difference between elemental bromine and elemental CHLORINE *(Br = 79.90 grams per mole and Cl = 35.45 grams per mole)*. Further, presently used field test kits assay only for TOTAL BROMINE. Bromine is commonly used in indoor commercial SPAS, probably due to these two factors. First, bromamines *(bromine and ammonia combined)* do not produce irritating odors as do chloramines. Second, bromine efficacy is less impacted than CHLORINE's at a higher pH, which typically occurs in a SPA environment. At pH of 7.5, 94% of bromine is HOBr, whereas at the same pH with no CYA, HOCl is 49% in chlorinated water. At pH of 8.0 bromine still has 83% HOBr, while in a chlorinated water, HOCl is 23% of FAC.[223, 230] Bromine is also not very common in outdoor POOLS because like CHLORINE, bromine is destroyed rapidly in sunlight. CYA was developed to combat the problem in chlorinated POOLS but does not provide a stabilizing effect for bromine. While reviewing the literature and surveillance data from CDC, evidence that outbreaks have occurred when required minimum bromine concentrations have been maintained is lacking *(i.e., likely due to lack of information on DISINFECTANT type)*. Therefore, in absence of any clear research, the decision to use common state requirements as the recommended concentrations is prudent. SPAS have been implicated in many skin disease outbreaks throughout the years. One paper suggests that a common culprit, *Pseudomonas aeruginosa* rapidly reestablished in SPAS *(less than 103 cells per mL)* when DISINFECTANT concentrations decreased below recommended concentrations *(CHLORINE: 3.0 ppm (mg/L); bromine: 6.0 ppm (mg/L))*. The authors studied the reoccurrence of bacteria following cleaning and halogen shock treatment[232]. This study emphasized the need for maintaining a consistent CHLORINE concentration in the SPA. CDC recommends 4-6 ppm *(mg/L)* for bromine. The MAHC recommends a follow up study to evaluate the efficacy of bromine on *P. aeruginosa*, since it is so commonly found in SPAS. Because bromine is a very common DISINFECTANT used in SPAS, prevention and treatment is essential. There are few peer-reviewed studies on bromine efficacy in real world POOLS and SPAS in the literature. Brown et al. reported reasonable bacterial control with 2.0 ppm TOTAL BROMINE in an 118,000 gallon *(447 m^3)* indoor POOL using BCDMH[240]. Normal day time BATHER COUNTS were around 0.21 persons per 500 gallons *(1893 L)* per hour but often increased to as high as 0.85 in the evening. The POOL did not use supplemental OXIDATION but did replace 5% of the water daily which likely contributed to the low reported ammonia nitrogen and organic nitrogen. Shaw reports a retrospective analysis of brominated and chlorinated semi-public SPAS in Alberta.[241] The data used was from the microbiological results of the weekly samples required under provincial regulations. The treatment systems compared include BCDMH *(OXIDATION method not specified)*, bromide salt regenerated by HOCl/potassium monopersulfate continuous feed, CHLORINE gas, hypochlorite *(type not specified)*, dichlor, and trichlor. The concentrations were generally in line with provincial regulations of 2 ppm *(mg/L)* TOTAL BROMINE and 1 ppm *(mg/L)* free CHLORINE. The brominated SPAS had a higher failure rate in all three bacterial parameters. There were several complaints of both contact dermatitis and *Pseudomonas* folliculitis from the brominated SPAS during the period studied. But due to the nature of the retrospective studies, it was not possible to link the reported RWIs to the concentration of the DISINFECTANT at the time of the complaint. It appears from composite data that when semi-public SPAS are operated using the EPA minimum halogen concentration of 1.0 ppm *(mg/L)* free CHLORINE or 2 ppm *(mg/L)* TOTAL BROMINE that *Pseudomonas aeruginosa* can be isolated from the brominated SPAS at greater than twice the frequency than from chlorinated SPAS.

Bromates

Ozone and bromide ions in water form HOBr and bromate ions. Bromates have been classified by the IARC as having sufficient evidence of carcinogenicity in laboratory animals. As a result, WHO has set a provisional drinking water guideline value of 10 ug/L. The EPA has established a maximum CONTAMINANT concentration of 10 ug/L for bromate in drinking water. BCDMH *(1-bromo-3-chloro-5, 5-dimethylhydantoin)* is the most common form of bromine used in commercial AQUATIC VENUES. The function of DMH is to inhibit the formation of bromates. At present there is little information on the functionality of using DMH in this manner. Since there is not a convenient field test kit available, an operator has no way of knowing what the DMH concentrations is in the water or when it might go below 10 ppm *(mg/L)* and allow bromates to form. We also do not know what the maximum safe concentration of DMH should be. To rely on DMH for bromate prevention, suitable test methods and further research are necessary. Operators should consider that ozone should likely not be used with bromine systems when there is a substantial likelihood of ingestion of the water. When ozone is used in conjunction with organic bromine sources *(BCDMH or DBDMH—another common source of bromine)*, the ozone readily converts residual bromide ion back to HOBr. This process reduces ozone. With the continued addition of BCDMH, DBDMH, or sodium bromide, the bromide concentrations will continue to climb in the AQUATIC VENUES. Continuous build-up of bromide will constantly reduce ozone, diminishing ozone's effective OXIDATION *(and destruction)* of organics and microorganisms in the water. Because of the wide variation in the concentration of bromide and the potential for bromate ingestion at least one ozone manufacturer does not recommend the installation of ozone units in bromine-treated facilities.

Disinfection

DISINFECTION using bromine is more complex but less well documented than DISINFECTION using CHLORINE. HOBr is the putative biocidal chemical species at recreational water pH. HOBr reacts with inorganic ammonia and forms monobromamine, dibromamine, and nitrogen tribromide, depending on the pH and concentration of ammonia.[242] These inorganic bromamines are all considered more biocidal than their corresponding CHLORINE analogs. HOBr is converted to inert bromide ion upon biocidal action in a manner similar to that seen with HOCl. One key difference between bromine and CHLORINE DISINFECTION is that bromide is readily oxidized back to HOBr and chloride is not. Further, HOBr is a much weaker oxidizer than HOCl. As a consequence of these two differences, exogenous OXIDATION of brominated waters *(e.g., shocking with CHLORINE)* is more important for safe operation than it is in chlorinated waters. In reviewing the published epidemiological studies on RWIs, it is often difficult to determine the exact treatment system used because the supplemental treatment system is not described. Further, presently used field test kits assay only for TOTAL BROMINE and are not capable of distinguishing free bromine from biocidal inorganic bromamines or from non-biocidal organic bromamines.

Bromamines

Current POOL and SPA operating manuals state that combined bromine *(bromamines)* is as efficacious as free bromine. This may be an over generalization of the complex nature of bromine chemistry. Bromine reacts with inorganic ammonia and forms analogous compounds *(Br_2, HOBr, monobromamine, dibromamine, and nitrogen tribromamide)* depending on the pH and concentration of ammonia.[242] All three bromine-ammonia derivatives are biocidal, but all three are also less stable than their corresponding CHLORINE compounds. As with their CHLORINE analogs, the ratios of the bromamines are highly dependent on the ratio of ammonia to bromine. Further, at low ammonia to bromine ratios the biocidal action appears to be substantially reduced[243]. The concentrations of ammonia that result in loss of bromine efficacy have been detected in SPA water[244]. At these documented concentrations of bromine and ammonia, the predominant bromamine is most likely dibromamine, which has an estimated half-life of 10 minutes[245]. Data on the efficacy of organic bromamines could not be found.

Future Research Needs

Cryptosporidium Inactivation

Methods to hyper-brominate recreational water in response to diarrheal fecal incidents have not been established. Research in this area is lacking.

Bromine Associated Rashes

Note to readers: These comments have been inserted to point future researchers toward an under-investigated area of public health and are not meant to imply a negative bias toward bromine. Literature reviews demonstrate many reports describing rashes associated with brominated water. These rashes fall into two general categories:

- Contact dermatitis due to brominated species in the water, and
- Dermal infections due to *Pseudomonas aeruginosa*.

These are most easily differentiated by incubation time. Most contact dermatitis reactions occur within 24 hours of immersion, sometimes within minutes. These are often referred to as "bromine itch" and are widely reported in the medical literature[246-248]. In most cases the putative etiological agent is thought to be bromamines. This type of dermatitis appears to be a result of cumulative exposure to bromine treated water and is particularly prevalent among medical personnel who provide aquatic physical therapy[249]. The exact compounds inducing contact dermatitis have not been identified. One study strongly suggests that the use of bromine with supplemental OXIDATION minimizes contact dermatitis[250]. In numerous epidemiological studies, poor water quality is commonly, but not always, reported *(Woolf and Shannon report an extreme example of a foamy POOL leading to multiple cases of contact-related RWI[251])*. The typical incubation period for *Pseudomonas aeruginosa* folliculitis is several days but can be as short as 24 hours. Outbreaks of *Pseudomonas aeruginosa* folliculitis are routinely associated with inadequate sanitation in both chlorinated and brominated waters. The minimum concentration to prevent such outbreaks has not been established but appears to be at least 1 ppm *(mg/L)* free CHLORINE and 2 ppm *(mg/L)* TOTAL BROMINE. A survey of the literature since the mid-1980s shows more dermal RWI outbreaks reported in brominated waters than in chlorinated waters. It is not known whether the reports reflect the true incidence, a bias in reporting of bromine systems, or a bias in reporting RWIs in SPAS, which tend to use bromine DISINFECTANTS. There are many unanswered questions surrounding bromine-treatment systems commonly used in AQUATIC VENUE DISINFECTION. After reviewing the literature, the MAHC has concluded the following research is essential to understanding bromine DISINFECTION.

Further research needs to address, in priority order:

- The efficacy of bromine to establish a minimum concentration for AQUATIC VENUES and warm water SPAS and THERAPY POOLS,
- The maximum bromine concentration that should be allowed,
- The contribution of bromamines to DISINFECTION and BATHER rashes,
- Methods to better control bromamines,
- Creation of a test kit to differentiate free bromine from combined *(as is currently practiced with CHLORINE)* in the water,
- Use of DMH in respect to bromate formation,
- Establish a safe maximum concentration,
- Creation of a test kit to establish concentrations in the water, and
- Fecal incident recommendations to control *Cryptosporidium* when using a bromine POOL.

5.7.3.1.2.3 Maximum Bromine Concentrations

Maximum bromine concentrations have been set to prevent exposure of BATHERS to high concentrations of bromine. Without an upper limit, very high concentrations might be present with no requirement to prohibit BATHERS from entering the water. Currently, the EPA Office of Pesticides registers products and approves labels for bromine. Currently bromine products on the market for use in recreational water are registered with use concentrations ranging from 1–8 ppm *(mg/L)*, depending on the product. At present time, no manufacturer specifies a concentration above 8.0 ppm.

5.7.3.1.3 Stabilizers

5.7.3.1.3.1 Cyanuric Acid

CYA is effective in protecting AVAILABLE CHLORINE from UV degradation. The chemical associates with CHLORINE to form chlorinated isocyanurates: trichlor *(trichloroisocyanuric acid)* and dichlor *(sodium*

dichloroisocyanuric acid). It can also be added as a separate chemical in the form of isocyanuric acid, commonly referred to as CYA. Trichlor is commonly found as tablets or sticks. Dichlor is a granular material, as is the isocyanuric acid. Products containing or forming CYA must be clearly labeled and directions provided to the user for proper use, limitations, toxicity, cautions, and effects. The most important factor in POOL DISINFECTION is the presence of sufficient concentrations of free CHLORINE. CYA is used to help maintain measurement of free CHLORINE concentrations in outdoor POOLS. CYA is not a DISINFECTANT, so it is not registered by the EPA. Stabilized CHLORINES are registered with the EPA as DISINFECTANTS; however, EPA has not reviewed efficacy data on CHLORINE in the presence of increasing stabilizer to date. The EPA reviewed efficacy data on dichlor and trichlor when it approved registrations for drinking water DISINFECTION. However, these data are not directly applicable to swimming POOLS where repeated doses lead to higher CYA concentrations.

Minimum Disinfection

Laboratory studies on the effect of CYA on CHLORINE DISINFECTION rates have been conducted with various microorganisms, including bacteria, protozoa, viruses, algae, and amebae. Various reports on the effects of CYA have also been published from field studies. The literature generally shows that CYA reduces the rate of microbial inactivation because CYA reversibly binds CHLORINE and reduces the aqueous concentration of HOCl.[230] For many of these studies, when results are plotted with log reduction vs. CT *(concentration times time)* value using a "C" concentration of measured DPD-FC, there is little correlation, but when plotted using a "C" concentration of calculated HOCl, there is a strong correlation indicating that HOCl is the primary disinfecting chemical species.[230]

The MAHC has a "SAFETY factor of 2 so that 2 ppm is the minimum concentration of DPD-FC when using stabilized products" *(2018 MAHC [3rd Edition] annex)*. This SAFETY factor of 2 is consistent with the concept that greater concentrations of CHLORINE are needed in the presence of CYA. However, even with the factor of 2, large variations in HOCl DISINFECTANT concentrations are seen, as shown in Table 5.7.3.1.1.2(d). An alternative approach is to maintain a given HOCl concentration which provides a minimum DISINFECTION concentration where the minimum DPD-FC concentration should increase proportionately with the CYA concentration.[230] A maximum CYA:DPD-FC ratio equates to a minimum HOCl concentration. Therefore, a minimum DISINFECTION concentration can be achieved by staying at or below a maximum CYA:DPD-FC ratio. The MAHC initially adopted a maximum CYA concentration of100 ppm, as has the World Health Organization[56]. The maximum allowable CYA concentration was reduced from 100 ppm to 90 ppm to avoid the need for operators to make dilutions since 100 ppm is the maximum concentration measured in the turbimetric test without diluting the sample. From a public health standpoint, the MAHC cannot support a prohibition of the use of cyanurate in most INCREASED RISK AQUATIC VENUES. The exception to this is operation of SPAS and THERAPY POOLS, which have issues with efficacy of agents against pathogens in biofilms and difficulties with maintaining needed pH *(SPAS)* and the use by increased risk groups of patients *(THERAPY POOLS)*. The MAHC calls for not using CYA or stabilized CHLORINE products in SPAS and THERAPY POOLS. Users should be aware that if there is a diarrheal incident in AQUATIC VENUES using CYA or stabilized CHLORINE products, owners and operators will need to close for more prolonged periods to respond to the diarrheal fecal incident by HYPERCHLORINATION compared with non-stabilized venues, circulate water through a SECONDARY TREATMENT, or replace the water in the AQUATIC VENUE per MAHC 6.5.3.2.1[127, 219] *(see MAHC 6.5.3 for further discussion)*.

Indoor Pools

There are no scientific, peer-reviewed studies in POOL water demonstrating operational or public health advantages for the use of CYA in indoor AQUATIC VENUES. CYA reduces degradation of DPD-FC from direct sunlight and so can have some benefits for indoor POOLS with sun exposure through large non-tinted glassed areas. While laminated glass blocks UVA radiation, smooth ordinary glass can transmit a large percentage of UVA, though not UVB[252]. The addition of CYA results in reduced HOCl concentration thereby reducing the rates of all reactions involving HOCl, including those that contribute to DISINFECTION, DISINFECTION BYPRODUCT formation, destruction of BATHER waste, and other CONTAMINANTS, and metal corrosion. CDC does not recommend CYA use for indoor AQUATIC VENUES.[253] As shown in Falk 2019, the annual probability of infection from *Giardia* is 13 times greater with 10 ppm CYA and 2 ppm DPD-FC compared with 2 ppm DPD-FC alone. The annual probability of infection from *Cryptosporidium* is 7 times greater and

the annual risk from *E. coli* increases from $<10^{-19}$ to $9.5x10^{-10}$ when using the default parameters defined in Falk 2019. From a public health standpoint, a prohibition of the use of cyanurate in indoor settings cannot be supported, based on the risk calculations in Falk 2019 where the risks in outdoor and indoor POOLS are considered identical. The requirements for increased DPD-FC concentration to address decreased efficacy from CYA applies to all AQUATIC VENUES, including indoor settings.

Effects of Cyanuric Acid on Microbial Inactivation

There are many references on the effect of CYA on microbial kill times *(CT INACTIVATION VALUES)*. In general, they show that the presence of CYA increases CT INACTIVATION VALUES, and the amount of this increase depends on the pH and the ratio of CYA to DPD-FC[230]. However, there are few reports that relate specifically to the issue of what concentrations of AVAILABLE CHLORINE and CYA are required to maintain a swimming POOL in a biologically satisfactory state. A risk model shows that the relative risk for gastrointestinal illness from *Cryptosporidium*, *Giardia,* and *E. coli* increased with increasing CYA:DPD-FC ratios[230]. Studies examining the effect of CYA on the DISINFECTION capacity of CHLORINE show that using CYA or stabilized CHLORINE slows down the inactivation times on bacteria, protozoa (*Naegleria gruberi* and *Cryptosporidium*), and viruses. Yamashita et al. concluded the addition of 30 mg/L of CYA to 0.5 mg/L of free CHLORINE *(to give a CYA:DPD-FC ratio of 60)* at pH 7.0 increased the time needed for DISINFECTION of 12 virus types by a factor of 4.8–28.8 compared with free CHLORINE alone[254, 255].

Table 5.7.3.1.3.1: 99.9% Inactivation time in buffer studies, 0.5 ppm (mg/L) FAC, 77°F/25° C

Organism	No CYA, min	30 ppm (mg/L) CYA, min
Poliovirus 1	0.8	5.6
Coxsackievirus A24	0.5	14.4
Enterovirus 70	0.12	2.5
Adenovirus type 3	0.14	2.1

Table 5.7.3.1.3.2(a): 99.9% Inactivation time in pool water studies, 1.0 ppm (mg/L) FAC, 77°F/25°C

Organism	No CYA, min	30 ppm (mg/L) CYA, min
Poliovirus 1	0.4	4.4

In a later study, Yamashita et al.[256] found "Total plate counts ranged from 0–1 per mL in the swimming POOLS treated with sodium hypochlorite and 0–51 in those with trichloroisocyanurates. In 11 of 12 water samples of three swimming POOLS using trichloroisocyanurates, poliovirus type 1 survived after 2-minute contact while in five samples poliovirus type 1 survived after 5-minute contact." The researchers concluded this showed that the risk of viral infection is greater in swimming POOL water treated with chlorinated isocyanurates than that with sodium hypochlorite. The addition of CYA similarly impaired the inactivation of poliovirus[257]. In a study inconsistent with studies on other microorganisms, CYA had a relatively minor effect on the algicidal efficiency of free CHLORINE[258]. There are few data regarding protozoa and the effect of CYA on inactivation though the DISINFECTION rate for *Naegleria gruberi* was reduced by CYA in laboratory-controlled CHLORINE demand free conditions[259]. Shields et al.[219] extended the previous findings by demonstrating that CYA significantly decreases the rate of inactivation for *Cryptosporidium* OOCYSTS. In this study a three-log reduction of OOCYSTS was found to take place in the presence of 20 ppm *(mg/L)* FAC. When 50 ppm *(mg/L)* CYA was introduced, the 10-hour kill rate was less than ½ log. Recent data show that 3-log inactivation of *Cryptosporidium* is possible with CYA concentrations of 15-16 ppm or less.[127] A 3-log inactivation could not be achieved with 50 ppm or 100 ppm CYA. A 1-log inactivation of OOCYSTS was achieved with 50 ppm cyanurate concentrations after an average contact time of 61.9 hours with 20 ppm FREE CHLORINE RESIDUAL, for an average estimated CT INACTIVATION VALUE for 1-log inactivation of 76,500 mg min/L. With 40 ppm FREE CHLORINE RESIDUAL and 50 ppm CYA, a 1-log inactivation of OOCYSTS was achieved after an average contact time of 17.2 hours, giving an average estimated CT INACTIVATION VALUE for 1-log inactivation of 40,000 mg min/L. Increasing the concentration

to 100 ppm CYA showed even more limited OOCYST inactivation, which did not differ much from natural decay/inactivation curves for *Cryptosporidium* in water. *Pseudomonas* inactivation in the presence of CYA was also studied in POOL water and it was found that increased CYA concentrations lengthened the kill times. The effect of CYA was greater as the concentration of CHLORINE in the water decreased[251]. Favero et al. found that at free CHLORINE concentrations of more than 0.5 ppm *(mg/L)*, *P. aeruginosa* was rarely found except in those POOLS which used sodium dichloroisocyanurate as a POOL DISINFECTANT. Three private swimming POOLS using sodium dichloroisocyanurate as a POOL DISINFECTANT were found to contain large numbers of the potential pathogen, *P. aeruginosa*[260]. Fitzgerald found concentrations of 25, 50, and 100 mg of CYA per liter had large effects on the *Pseudomonas* kill rate of 0.1 mg/L free CHLORINE but this effect diminished with increasing free CHLORINE content *(0.25, 0.5 mg/L)*. Fitzgerald found concentrations of 25, 50, and 100 mg of CYA per liter had little effect on the kill rate of 0.5 mg of CHLORINE plus enough ammonia to convert all of the CHLORINE to monochloramine *(≥0.1 mg of NH_3-N [ammonia] per liter)*[231].

Diarrheal Fecal Incident Response

The use of stabilized CHLORINE is not recommended in response to formed stool or vomit incidents in the water or bodily fluid spills on surfaces outside of the water. MAHC requirements for HYPERCHLORINATION and remediation are inadequate to inactivate *Cryptosporidium* in AQUATIC VENUES using stabilized CHLORINE. CYA slows DISINFECTION *(see MAHC Annex 5.7.3.1.3.1 for more discussion)*. Therefore, a higher CHLORINE concentration is necessary to reach the CT INACTIVATION VALUE for *Cryptosporidium* inactivation in AQUATIC VENUES that use CHLORINE stabilizers.[128] As CYA concentration rises, parasite inactivation is inhibited to the point where inactivation is similar to natural decay of the parasite.[127] As a result, concentrations of CYA must be reduced to reach 3-log inactivation using HYPERCHLORINATION. Recent data show that 3-log inactivation of *Cryptosporidium* is possible with CYA concentrations of16 ppm.[127]

Based upon Murphy, et al., 2015, "existing responses to diarrheal fecal incidents *[i.e., high-risk Cryptosporidium contamination events]* and suspected or confirmed recreational water–associated outbreaks of cryptosporidiosis that rely on HYPERCHLORINATION are inadequate when used in *[AQUATIC VENUES]* that have higher concentrations of cyanurate *(50−100 mg/L)*, including concentrations currently acceptable in many state AQUATIC VENUE CODES and the Model Aquatic Health Code. Such AQUATIC VENUE would need to reduce CYA concentrations to achieve 3-$\log_{10}$ inactivation conditions or employ an alternate DISINFECTANT technique for remediation." A 3-log inactivation could not be achieved with 50 ppm or 100 ppm CYA. A 1-log inactivation of OOCYSTS was achieved with 50 ppm cyanurate concentrations after an average contact time of 61.9 hours with 20 ppm FREE CHLORINE RESIDUAL, for an average estimated CT INACTIVATION VALUE for 1-log inactivation of 76,500 mg min/L. With 40 ppm FREE CHLORINE RESIDUAL and 50 ppm CYA, a 1-log inactivation of OOCYSTS was achieved after an average contact time of 17.2 hours, giving an average estimated CT INACTIVATION VALUE for 1-log inactivation of 40,000 mg min/L. Increasing the concentration to 100 ppm CYA showed even more limited OOCYST inactivation, which did not differ much from natural decay curves for *Cryptosporidium* in water. Because a 3-log OOCYST inactivation was achieved with 16 ppm CYA and was not achieved with 50 ppm CYA, the remediation protocol must be conducted in water with ≤15 ppm CYA. If the CYA concentration is above 15 ppm, the AQUATIC VENUE will need to be partially drained and refilled to reduce the CYA concentration. Alternate methods of reducing the CYA concentration are acceptable, as long as test data shows that the CYA concentration is at or below 15 ppm.

The following table shows how a DPD-FC concentration of 5 ppm by increasing CYA concentration results in an HOCl concentration less than that with decreasing FREE CHLORINE RESIDUAL.

Table 5.7.3.1.3.2(b) Superchlorination with DPD-FC 5 ppm [230]

CYA, ppm	DPD-FC, ppm	HOCl, ppm	Contact time, hours
0	5	2.42	51
10	5	0.367	336
15	5	0.199	620
30	5	0.078	1,582
50	5	0.043	2,870

CYA, ppm	DPD-FC, ppm	HOCl, ppm	Contact time, hours
70	5	0.029	4,256
90	5	0.022	5,610

The use of these large CHLORINE dosages can be costly due to the cost of the chorine, the cost of CHLORINE neutralization at the end of the treatment, and any pH adjustments that are required by the use of these chemicals.

The keys to minimizing outbreaks due to fecal incidents are prevention and rapid response. BATHERS and caregivers of BATHERS ages less than 5 years should be educated about healthy swimming practices *(e.g., not swimming when sick with diarrhea)* to keep *Cryptosporidium* out of the water. POOL operators should be educated on *Cryptosporidium* response, which should be delineated written policy and documented in records, and risks.

Toxicity

The maximum CYA concentration of 90 ppm *(mg/L)* should be considered protective from a toxicological perspective. Using an assumption that 100 mL of POOL water is swallowed per swim session; the World Health Organization *(WHO)* concluded that CYA concentrations in POOLS should be below 117 ppm *(mg/L)*. This is based on a tolerable daily intake *(TDI)* for anhydrous sodium dichloroisocyanurate *(NaDCC)* of 2 mg/kg of body weight, which translates to an intake of 20 mg of NaDCC *(or 11.7 mg of CYA per day)* for a 10 kg child. The EPA SWIMODEL, relying on somewhat lower exposure assumptions, would yield a higher acceptable concentration for CYA.

Using an assumption that a 1-year old child swallows 100 mL of POOL water per swim session; the World Health Organization (*WHO*) concluded that CYA concentrations in POOLS should be below 117 ppm (*mg/L*).[56] This is based on a tolerable daily intake (*TDI*) of 1.17 mg of CYA/kg/day (or 11.7 mg of CYA per day~~)~~ for a 10 kg child). However, the WHO calculation is overly conservative. The WHO calculation is a long-term *(chronic)* exposure calculation, based on the chronic NOAEL *(117 mg/kg bw/day)*, and makes the unreasonable assumption that the 1-year-old child visits a POOL every day. In contrast, the SWIMODEL more properly averages the exposure over the entire year. For a child, NSF's SWIMODEL calculation used a maximum of 102 visits per year, or about 28% of the days in a year. Averaging the chronic exposure over the entire year, rather than assuming exposure every day, would raise WHO's calculated CYA limit by a factor of 3.6, giving a limit of > 400 ppm CYA instead of 117 ppm.

A short-term *(single-day)* exposure calculation must use an acute NOAEL; however, the EPA has concluded that no apparent endpoint has been determined for acute exposure to CYA for the general population.[261] Therefore, a single-day acceptable exposure cannot be calculated for a 1-year old child.

Furthermore, the WHO calculation is based on a 22 lb. *(10 kg)* child *(about 1-year old)* and used an ingestion rate of 100 mL per POOL visit. This is twice the ingestion rate of 50 mL/visit used in the NSF's SWIMODEL calculation for a larger, older child *(70 lb or 32 kg, 6– < 11 year)* competitive swimmer. No experimental data is available to substantiate the WHO's assumed ingestion rate for a 1-year old *(10 kg)* child.[262] Using a lower, more reasonable, ingestion rate would proportionately raise the calculated CYA limit.

Note that the reference dose *(RfD)* used in the SWIMODEL and the tolerable daily intake (*TDI*) used in the WHO calculation are essentially the same value. Both include a SAFETY factor of 100, that is, they equal the accepted chronic NOAEL divided by 100.

Research

Preliminary, unpublished research suggests the relationship of the CYA: DPD-FC ratio to HOCl, of HOCl to DISINFECTION rates, and of relative risk due to regular fecal sloughing at low HOCl concentrations. Additional research should refine the factors used in the relative risk model and validate the model by comparing model predictions with experimental data. Further research should be done with fecal incidents and the effects of HOCl concentrations on DISINFECTION BYPRODUCTS and CONTAMINANT removal. Additionally, a test kit should be developed to test lower and higher concentrations of CYA. During RWI outbreaks, it is strongly recommended that the investigation team measure CYA concentrations.

5.7.3.1.3.3 CYA Limit in Aquatic Venues

Cyanuric acid *(CYA) (CAS# 108-80-5)* has undergone a peer-reviewed risk assessment to establish an oral reference dose *(RfD)* of 1.3 mg/kg-day. The risk assessment's key study identified the critical effect as decreased survival in male rats and lesions of the urinary tract and heart. Using the default relative source contribution of 20%, the allowable systemic exposure from swimming pools and spas is 0.26 mg/kg-day. Using the EPA SWIMMODEL *(2003a)* equations and assumptions from NSF/ANSI/CAN 50, Section 27, a concentration limit for exposure in POOL and SPA water was established. Multiple populations and age groups are considered, and adult competitive swimmers are the most susceptible group for cumulative daily exposure. The allowable concentration in POOL and SPA water is limited to 300 mg/L in order to avoid adverse health effects with chronic exposure.

The effective dose of cyanuric acid for stabilization of CHLORINE-based disinfectants is far below 300 mg/L. In order to reduce health risks to swimmers, AQUATIC VENUES should be closed when the cyanuric acid concentration exceeds the 300 mg/L limit.

5.7.3.1.4 Compressed Chlorine Gas

Installation/use of compressed CHLORINE gas is prohibited for new AQUATIC FACILITIES. However, there are existing facilities that continue to use these gas systems. Because of the potential hazard, it is important that existing facilities meet STORAGE, ventilation, handling, and operator training requirements if use is to continue. If these requirements are not met, use must be discontinued, and a properly designed/sized and approved DISINFECTANT system must be installed. The following design criteria from an existing health CODE provide additional details for consideration when evaluating acceptability of an existing compressed gas installation.

- ***Location.*** The chlorinator room shall be located on the opposite side of the POOL from the direction of the prevailing winds. CHLORINE STORAGE and chlorinating equipment shall be in a separate room. This room shall be at or above grade.
- ***Venting*** The CHLORINE room shall have a ventilating fan with an airtight duct beginning near the floor and terminating at a safe point of discharge to the out-of-doors. A louvered air intake shall be provided near the ceiling. The ventilating fan shall provide one air change per minute and operate from a switch located outside the door.
- ***Door*** The door of the chlorinator room shall not open to the swimming POOL, but shall open outward directly to the exterior of the building. The door shall be provided with a shatterproof inspection window and should be provided with "panic hardware."
- ***CHLORINE Cylinders.*** CHLORINE cylinders shall be anchored. The cylinders in use shall stand on a scale capable of indicating gross weight with one-half pound accuracy. STORAGE space shall be provided so that CHLORINE cylinders are not subjected to direct sunlight. STORAGE space shall be in an area inaccessible to a person or people.
- ***Injection Location*** Mixing of CHLORINE gas and water shall occur in the CHLORINE room, except where vacuum-type chlorinators are used.
- BACKFLOW The chlorinators shall be designed to prevent the BACKFLOW of water or moisture into the CHLORINE gas cylinder.

5.7.3.1.5 Salt Electrolytic Chlorine Generators, Brine Electrolytic Chlorine or Bromine Generators

In-line generators shall use only POOL-grade salt dosed into the POOL to introduce CHLORINE into the POOL vessel through an electrolytic chamber to avoid potential health risks associated with DISINFECTION BYPRODUCTS forming from salt impurities, including bromide and iodide. For example, Kristensen et al. directly correlated bursts of bromodichloro-methane formation to the addition of salt to POOL water over a MONITORING period of more than 1 year.(263) In a comparison study of common DISINFECTANT methods, Lee et al. found salt brine electrolysis formed the highest concentrations of bromodichloro-methane, dibromochloro-methane and bromoform.(264) Zwiener et al. noted that iodized table salt should not be used in salt POOLS because iodized DISINFECTION BYPRODUCTS, which are generally more toxic than chlorinated

DISINFECTION BYPRODUCTS, could form.[12] Additionally, there is a perception by some that salt water POOLS can be operated with table salt *(which is commonly iodized)*.

5.7.3.2 Secondary or Supplemental Treatment Systems

Due to the risk of outbreaks of RWIs associated with halogen-tolerant pathogens such as *Cryptosporidium*, it is strongly recommended that all AQUATIC VENUES include SECONDARY TREATMENT to minimize the risk to the public associated with these outbreaks. All existing regulations covering fecal events or detection of pathogens must still be adhered to when SECONDARY TREATMENTS are utilized. SECONDARY TREATMENT S can only minimize the risk and are not a guarantee of treatment due to the possibility of cross contamination of the POOL or water feature and the time required to pass the entire volume of water through the treatment process. As the general effectiveness of a SECONDARY TREATMENT is affected by the AQUATIC VENUE TURNOVER RATE and mixing/circulation within the AQUATIC VENUE, the MAHC requirements for filter recirculation and TURNOVER RATES must be followed. The performance of SECONDARY TREATMENT will be enhanced when the shortest TURNOVER TIMES are achieved for any type of AQUATIC VENUE. The use of certain types of AQUATIC VENUES presents an increased risk of pathogen transmission to users. These AQUATIC VENUES include THERAPY POOLS, WADING POOLS, and INTERACTIVE WATER PLAY AQUATIC VENUES. Given that BATHERS in these types of AQUATIC VENUES frequently have naive immune systems *(e.g., children ages 5 years and older adults)*, higher prevalence of disease *(e.g., children less than 5 years of age and older adults)*, compromised immune systems, or open wounds, additional precautions against RWIs are warranted. CDC data on public AQUATIC VENUES indicate DISINFECTANT violations were identified during 9.2% of POOL, 19.2% of SPA, 19.2% of WADING POOL, and 10.1% of interactive water play venue routine inspections[1]. The use of INTERACTIVE WATER PLAY AQUATIC VENUES has previously been associated with outbreaks of gastroenteritis. In 1999, an estimated 2,100 people became ill with *Shigella sonnei* or *Cryptosporidium* infections after playing at an "interactive" water fountain at a beachside park in Florida[265]. In one of the largest outbreaks reported, approximately 2,300 persons developed cryptosporidiosis following exposure to a New York spray park. The environmental investigation revealed that filtration and DISINFECTION of the recycled water were not sufficient to protect the PATRONS from this disease. In response, emergency legislation, which required the installation of SECONDARY TREATMENT *(e.g., UV radiation or ozonation)* on water returning through the spray features, was passed.[266]

5.7.3.2.1 Ultraviolet Light

5.7.3.2.1.2 Log Inactivation

Records of the correct calibration, maintenance, and operation of SECONDARY TREATMENT S should be maintained by the facility's management.

5.7.3.2.1.4 Calibrated Sensors

Owners/operators need to consult the unit manual and the manufacturer's manual for guidance on how to accomplish this and who is qualified to do the job.

5.7.3.2.3 Copper / Silver Ions

EPA has set current drinking water STANDARDS at 1.3 ppm for copper and 0.10 ppm for silver, which are generally accepted in the states that have requirements for this treatment. These ion generation systems are not meant to replace disinfecting halogen and the minimum concentrations must continue to be provided. The manufacturer's recommended procedures should be followed to avoid the potential of staining; operating the POOL with copper concentrations outside the recommended range can cause staining. Copper-based algaecides should not be used in these systems since use of these products increase the concentration of copper in the AQUATIC VENUE and increases the potential to cause health effects or stain surfaces. In addition, studies have shown that the presence of copper in POOL water has a catalytic effect on the formation of THMs[267].

5.7.3.3 Other Sanitizers, Disinfectants, or Chemicals

The MAHC has opted to not include lists of DISINFECTANTS that should not be used in AQUATIC VENUES versus discussing that these chemicals must not pose a hazardous issue with the CHLORINE or bromine DISINFECTANTS in use and that all water quality criteria must be met.

PHMB

Polyhexamethylene biguanide hydrochloride *(PHMB)* is a polymeric antimicrobial that has been used as an alternative to CHLORINE and bromine. PHMB is often referred to as biguanide in the industry. The formal name for PHMB on EPA accepted labels is "Poly *(iminoimidocarbonyliminoimido-carbonyl iminohexamethylene)* hydrochloride." The EPA has registered PHMB for use in POOLS and SPAS as a "SANITIZER" with label directions requiring that the concentration be maintained 30–50 ppm *(mg/L)* as product *(6–10 ppm [mg/L] of active ingredient)*. PHMB is not an oxidizer and must be used in conjunction with a separately added product. Hydrogen peroxide is the strongly preferred oxidizer. The vast majority of the PHMB used in POOLS and SPAS is used in private residences, but a limited number of public facilities have used PHMB. Because of its limited use in public AQUATIC FACILITIES, there are few independent studies on the efficacy of PHMB in recreational water. Studies report that the rate of kill of bacteria is slower than that of CHLORINE under laboratory conditions. However, the EPA found that manufacturer's generated data demonstrated adequate efficacy under the EPA guideline DIS/TSS-12 to grant registration under FIFRA and without regard to whether the facility is public, semi-public, or private. As part of their registration process, the EPA does not distinguish between public and private facilities. The efficacy data analyzed by the EPA is company confidential and has not been reviewed as part of the development of the MAHC. There are no known published studies of the efficacy of PHMB against non-bacterial POOL and SPA infectious agents *(e.g., norovirus, hepatitis A, Giardia sp., Cryptosporidium spp.)* under actual use conditions. PHMB is generally compatible with both UV and ozone, but both UV and ozone will increase the rate of loss of PHMB. Since SECONDARY TREATMENT require the use of a halogen as the primary DISINFECTANT, the use of PHMB, even with a SECONDARY TREATMENT is problematic. PHMB IS NOT compatible with CHLORINE or bromine. POOLS using PHMB have a serious treatment dilemma for control of an outbreak caused by *Cryptosporidium* at least suspected of being linked to an AQUATIC VENUE or remediation of a diarrheal fecal incident. The addition of 3 ppm *(mg/L)* of CHLORINE to a properly maintained PHMB-treated POOL results in the precipitation of the PHMB as a sticky mass on the POOL surfaces and in the filter. Removal of the precipitated material can be labor intensive. Testing for PHMB requires special test kits. Conventional kits for halogens are not suitable. PHMB test kits are readily available at most specialty retail POOL stores and online.

Hydrogen Peroxide

Hydrogen peroxide is not registered by the EPA as a DISINFECTANT for recreational water. Since it is not registered, the use of hydrogen peroxide as a recreational water DISINFECTANT, or any market claims that implies hydrogen peroxide provides any biological control in recreational water is a violation of FIFRA. Hydrogen peroxide has been granted registration by the EPA as a hard surface DISINFECTANT and several other applications. The EPA Registration Eligibility Document *(RED)* on hydrogen peroxide is available from the EPA website at https://archive.epa.gov/pesticides/reregistration/web/pdf/4072fact.pdf. The EPA posts PDF copies of accepted product labels on the National Pesticide Information Retrieval System website (https://www.npirs.org/). Product claims for uses and concentration can be verified by reading the PDF of the EPA stamped and accepted copy of the product use directions at this website. When used as a hard surface DISINFECTANT, hydrogen peroxide is normally used at around 3%. When used in recreational water, hydrogen peroxide is used at 27–100 ppm *(mg/L)*, which is 1111 and 300 times, respectively, more dilute than that used on hard surfaces. Borgmann-Strahsen evaluated the antimicrobial properties of hydrogen peroxide at 80–150 ppm *(mg/L)* in simulated POOL conditions.[268] Whether 150 ppm *(mg/L)* hydrogen peroxide was used by itself or in combination with 24 ppb of silver nitrate it had negligible killing power against *Pseudomonas aeruginosa*, *E. coli. Staphylococcus aureus, Legionella pneumophila* or *Candida albicans*, even with a 30-minute contact period. In the same tests, the sodium hypochlorite controls displayed typical kill patterns widely reported in the literature. Borgmann-Strahsen concluded that hydrogen peroxide, with or without the addition of silver ions, was, "no real alternative to CHLORINE-based DISINFECTION of swimming POOL water from the microbiological point of view."

5.7.3.3.1 Chlorine Dioxide

CHLORINE dioxide is not presently registered by the EPA for any use in recreational water. Since it is not registered, the use of CHLORINE dioxide as an antimicrobial treatment *(e.g., DISINFECTANT, SANITIZER, algaecide, slimicide, biofilm control agent)* in recreational water or any market claims that implies CHLORINE dioxide provides any biological control in recreational water is a violation of FIFRA. CHLORINE dioxide has

been granted registration by the EPA as an antimicrobial for other applications, including drinking water. One product was previously registered as a slimicide for use in PHMB-treated recreational water, but that registration has since been dropped. The EPA Registration Eligibility Document *(RED)* on CHLORINE dioxide is available from the EPA website at https://archive.epa.gov/pesticides/reregistration/web/pdf/chlorine_dioxide_red.pdf. The EPA posts PDF copies of accepted product labels on the National Pesticide Information Retrieval System website (https://www.npirs.org/). Product claims for uses and concentration can be verified by reading the PDF of the EPA stamped and accepted copy of the product use directions at this website. CHLORINE dioxide has the potential to be an alternative remediation tool, but it has not yet been approved by EPA for this use and can be hazardous unless appropriate SAFETY protocols are included. CDC has determined that CHLORINE dioxide can be used instead of HYPERCHLORINATION for rapid inactivation of *Cryptosporidium (3-log inactivation in 105 to 128 minutes)* and that this effect was synergistically enhanced with a FREE CHLORINE RESIDUAL in place.[269] This suggests CHLORINE dioxide might be very useful in rapidly remediating contaminated AQUATIC VENUES in the absence of BATHERS.

Potential for Using Chlorine Dioxide in the Future

CDC is interested in further exploring CHLORINE dioxide as a remedial treatment for *Cryptosporidium* and *Legionella*. Published studies, including the *EPA Alternate Disinfection Manual* for drinking water shows that CHLORINE dioxide could be a very rapid remedial treatment for these pathogens. If the EPA registration status of CHLORINE dioxide changes, CHLORINE dioxide use should be reconsidered under adequate SAFETY precautions.

Provisions for Emergency Use of Chlorine Dioxide

Even though CHLORINE dioxide is not presently registered for use in recreational water, it is possible to use it under Section 18 of FIFRA. An example of this would be the remediation of a *Legionella*-contaminated SPA, where other treatments were proven to be ineffective. More information on emergency exemptions can be found on the EPA website at https://ordspub.epa.gov/ords/pesticides/f?p=124:2. Because of the lack of existing use directions and potential for occupational exposure, it is strongly suggested that a certified industrial hygienist be included in developing emergency treatment plans.

5.7.3.3.2 Clarifiers, Flocculants, and Defoamers

AQUATIC VENUES might benefit from the use of one or more of these types of products. There are numerous brands available that are formulated for commercial POOLS and SPAS. Each product is marketed for a specific procedure. Each might contain one or more natural or synthetic polymers, chemical or metallic ingredients. Neither the efficacy nor the SAFETY of product chemistry of these products has been reviewed by the EPA or any other federal agency. The state of California does require submission of a detailed data package prior to registration. Products sold in the state of California must have the state registration number on the label as required by the California Code of Regulations, Title 3. Division 6, Chapter 2, Subchapter 1, Article 10. Pesticides and Pest Control Operations. Products registered in California but sold outside of the state usually, have the California registration number on the label but are not required to do so. Any local, state, territorial, federal, and tribal agencies concerned about a particular product could request the producer supply the California registration number and then verify the status of the product with the California Department of Pesticide Regulation.

5.7.3.4 pH

There are three reasons to maintain pH within the range specified:

- Effect of pH on the efficacy of CHLORINE,
- BATHER comfort, and
- Maintenance of balanced water.

Each of these reasons are discussed briefly below.

Effect of pH on Chlorine

The efficacy of CHLORINE/HOCl is dramatically impacted by pH and therefore pathogen inactivation can be severely affected by higher pH where only a small percentage of free CHLORINE is HOCl. Lower pH below

this range allow a greater percentage of free CHLORINE to be HOCl. Further data are needed to ensure that lower pH *(e.g., 6.8–7.2)* does not adversely impact membranes, particularly eyes. The practice of maintaining the pH between 7.0 and 7.8 has been developed by coupling physical chemistry with empirical observations. There is no definitive peer-reviewed study that extensively covers the subject of pH in POOL and SPA water except those showing the titration of HOCl and the importance of pH for assuring maximal efficiency. CHLORINE used in POOLS refers to HOCl, a weak acid that readily dissociates to form hypochlorite *(OCl-)* and hydrogen ion *(H+)*. The mid-point of the dissociation *(the pKa)* is approximately at pH 7.5. Functionally, this means that at pH of 7.5, 50% of the free CHLORINE present will be in the form of HOCl and 50% will be in the form of hypochlorite. As the pH decreases below 7.5, the proportion of HOCl increases and proportion of hypochlorite ion decreases. The opposite occurs as the pH increases above 7.5. Numerous investigators have reported that HOCl is approximately 100 times more effective at killing microorganisms than the hypochlorite ion[223, 270]. Thus, from a public health perspective, historically it has been considered desirable to maintain the pH to maximize the portion of HOCl portion of the free CHLORINE present in the water. More recently, it has been argued that the risk of infection is more dependent on the CYA:DPD-FC ratio than on pH[230].

As shown in the graph below, the portion of FREE CHLORINE that is HOCl is lowered significantly as the pH rises when CYA is not present, dropping by 52.7 relative percent from a proportion of FREE CHLORINE of 48.6% to 23.0% as the pH rises from 7.5 to 8.0. However, with 30 ppm CYA *(and 2 ppm DPD-FC)*, the HOCl drops 15.1 relative percent from 1.36% to 1.15%. Since the HOCl concentration is so much higher when CYA is not present, the seemingly large drop at high pH results in an HOCl concentration that is still higher than what is present with typical POOL CYA concentrations. For instance—with 1 ppm DPD-FC, no CYA, and pH 8.0—the HOCl is 0.23 ppm. While with 20 ppm CYA and pH 7.0, the HOCl is 0.027 ppm. The pH is still important when hyperchlorinating for DISINFECTION after a diarrheal incident (i.e., high-risk *Cryptosporidium* contamination event). In the presence of CYA, the effect of pH on HOCl concentrations is greatly diminished as shown in the following graph and table:

Table 5.7.3.4.1 Impact of pH on HOCl concentration for various concentrations of CYA. The curves were calculated using 1 ppm DPD-FC, 77°F/25 °C and 1,000 ppm TDS[230].

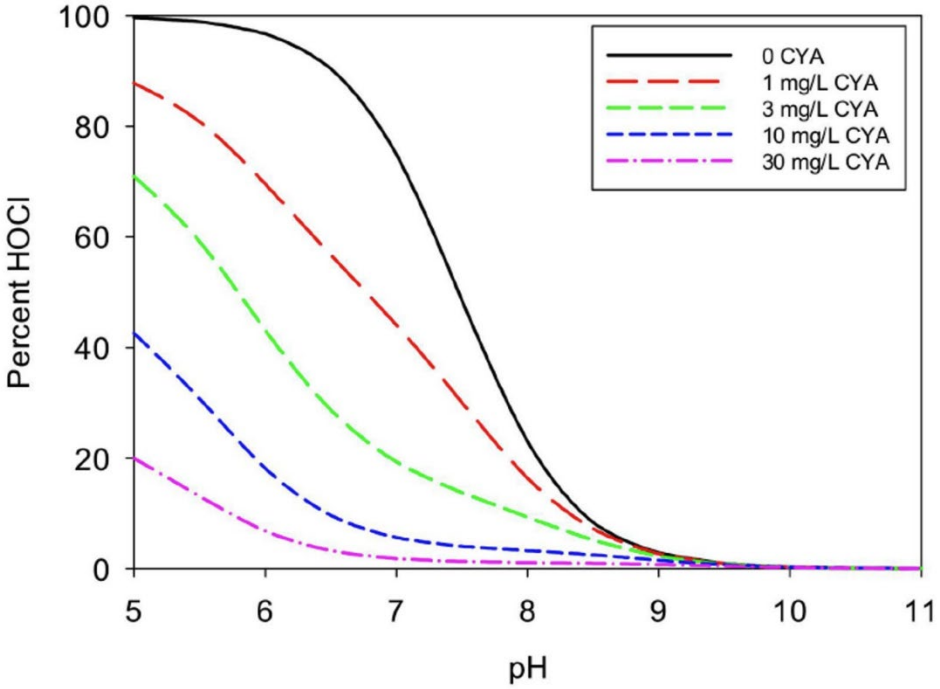


Table 5.7.3.4.2 HOCl concentrations calculated with 1 ppm DPD-FC, 77°F/25 °C, and 1,000 ppm TDS.

pH	0 ppm CYA	10 ppm CYA	20 ppm CYA	30 ppm CYA	40 ppm CYA	50 ppm CYA
7.2	0.6533	0.0480	0.0233	0.0154	0.0115	0.0091
7.4	0.5431	0.0424	0.0206	0.0136	0.0101	0.0081
7.6	0.4286	0.0384	0.0188	0.0124	0.0093	0.0074
7.8	0.3212	0.0353	0.0175	0.0116	0.0087	0.0069
% pH: 7.2–7.8	51%	26%	25%	25%	24%	24%

There is approximately a 50% reduction in HOCl concentration when raising the pH from 7.2 to 7.8 without any CYA. If the CYA concentration is 10 ppm or greater, then the reduction in HOCl concentration for the same increase in pH is approximately 25%.

Bather Comfort

As BATHERS enter the water, their skin and eyes come into direct contact with the water and its constituent components. In general, the eyes of BATHERS are more sensitive to irritation than the skin. The normal pH of human tears varies 6.5–7.6 with a mean of 7.0 in one study(271) and a mean of 7.5 *(SD +/- 0.23)* in another study(272). Studies on the sensitivity of BATHERS' eyes to pH changes in the water show wide variations in tolerance limits. One study showed no variation in irritation at pH 7.0–9.0 and concluded that low salt concentrations and the presence of chloramines or higher CHLORINE concentrations were the primary drivers of eye irritation(273). The tolerance of the eye to shifts in pH is also impacted by the concentration of free CHLORINE, COMBINED CHLORINE, and alkalinity.

Maintenance of Balanced Water

The pH has a direct influence on the SATURATION INDEX where a low pH can lead to the water dissolving calcium carbonate from plaster surfaces while a high pH can lead to calcium carbonate scaling. A low pH can also increase the rate of metal corrosion. Maintaining properly balanced water is therefore important for prevention of plaster degradation in POOLS.

Potential for Lowering pH in the Future

During the review of the data, there was broad interest in lowering the minimum pH. This would increase the efficacy of the CHLORINE, particularly when CYA is not present, by increasing the proportion of HOCl *(at the expense of hypochlorite)* and thus increase DISINFECTION efficacy. Lowering the minimum pH by 0.2 will increase the operating range and allow more effective DISINFECTION. Since the setpoint pH remains within a range that is only broadened, no operational change is required. Many manufacturers include a pH range on equipment use so that lowering the pH could void the warranty; operators should be mindful of this when lowering pH at AQUATIC VENUES.

5.7.3.5 Feed Equipment

The CHLORINE Institute has checklists and guidance for working with compressed CHLORINE gas at: https://www.chlorineinstitute.org/stewardship-resources.

5.7.3.5.1 Acceptable Chemical Delivery

5.7.3.5.1.2 Installed and Interlocked

Periodic visual inspections of the electrical interlock system should be performed to determine if the system appears to be installed per manufacturer's instructions and has not been altered.

5.7.3.5.1.2.2 Bather Re-entry

The 5-minute wait period after turning the RECIRCULATION SYSTEM back on before allowing BATHERS to reenter the AQUATIC VENUE is to ensure the system did not overfeed chemicals into the recirculation lines that could potentially expose BATHERS. If such an event did occur, the wait period will allow staff to determine if a gas release does occur, which will help protect BATHERS and staff from exposure to dangerous CHLORINE gas that potentially formed during the pause in recirculation pump flow if chemical feed pumps continued to

pump chemicals into the system. This short delay and check could prevent many of the exposures that occur during these events in addition to interlocks on the recirculation and chemical feed systems.[160]

5.7.3.7 Automated Controllers and Equipment Monitoring

5.7.3.7.7 Ozone System

As a SECONDARY TREATMENT, it is critical to MONITOR the system on a regular basis to ensure it is performing as required and, if not, repaired.

5.7.3.7.8 UV System

As a SECONDARY TREATMENT, it is critical to MONITOR the system on a regular basis to ensure it is performing as required and, if not, repaired.

5.7.4 Water Sample Collection and Testing

5.7.4.3 Bulk Water Sample

When collecting samples from AQUATIC VENUE, an 18-inch *(45.7 cm)* water depth for sample collection is recommended. Both NSPF's Pool and Spa Operator Handbook™ and NRPA's AQUATIC FACILITY Operator Manual instruct the operator to reach at least 18 inches *(45.7 cm)* below the water's surface to collect the water sample. In an outdoor POOL, there is chemical interaction with UV light at the surface which will affect the reading. Most of the chemical CONTAMINANTS in a POOL are located within the top 18 inches *(45.7 cm)*, which is why most studies of POOL CONTAMINANTS are performed by collecting samples at a depth of less than or equal to 30 centimeters *(11.8 inches)* below the POOL water surface.[58, 274] These CONTAMINANTS will give false pH and DISINFECTANT readings in indoor and outdoor AQUATIC VENUES. To sample, plunge the assembly *(mouth first)* quickly to the marked depth, invert, and let the bottle fill. Remove when full of water and begin testing. A consistent sampling point is important, and this sampling point is the feed into the ORP controller which is required by MAHC 5.7.3.7.1. However, the purpose of the samples in MAHC 5.7.4.3 is to ensure that the DISINFECTANT feed settings based on the ORP are sufficient to ensure that there is a DISINFECTANT residual throughout the POOL at all times BATHERS are present. Since there is usually a higher concentration of BATHERS *(and hence BATHER load)* in the shallow end, it is especially important to get samples from that area. In other words, the fixed sampling point of the ORP controller provides the variation over time *(temporal variation)*, while the rotating sample points provide the spatial variation. It is important to cover both kinds *(temporal and spatial)* of variation.

5.7.4.4 Aquatic Venue Water Chemical Balance

Water balance is a term used to describe the tendency of water to dissolve *(corrode)* or deposit minerals *(form scale)* on surfaces contacted by the water. Balanced water will neither corrode surfaces nor form scale. Factors that impact water balance are pH, hardness, alkalinity, dissolved solids, and temperature. The presently used water balance parameters are used to protect AQUATIC VENUE equipment and surfaces from deleterious effects of corrosion and scale formation. Improperly balanced water is not in itself a threat to public health. Water balance is expressed in several ways but the most common one is by the SATURATION INDEX. Each factor in the SATURATION INDEX equation can vary within a limited range and the water is still considered balanced. Shifts in pH have a substantial impact on water balance. Water balance chemistry is discussed extensively in all POOL operator classes and is well beyond the scope of this Annex.

5.7.4.4.1 Total Alkalinity

Total alkalinity is closely associated with pH, but rather than a measure of hydrogen ion concentration, it is a measure of the ability of a solution to neutralize *(buffer)* hydrogen ions. Expressed in parts per million *(ppm)*, total alkalinity is the result of alkaline materials including carbonates, bicarbonates, and hydroxides - mostly bicarbonates. As noted in the MAHC, the ideal range is 60–180 ppm. This acid neutralizing *(buffering)* capacity of water is desirable because it helps prevent wide variations in pH *(pH bounce)* whenever small amounts of acid or alkali are added to the POOL. Total alkalinity is a measure of water's resistance to change in pH and is a source of rising pH itself from the outgassing of carbon dioxide.

Too Low

If total alkalinity is too low: pH changes rapidly when chemicals or impurities enter the water. pH might drop rapidly when using net acidic sources of CHLORINE or other acidic chemicals *(e.g., Trichlor (trichloro-s-triazinetrione)*, Dichlor *(sodium dichloro-s-triazinetrione), potassium monopersulfate)*, causing etching and corrosion.

Raising Total Alkalinity

Total alkalinity can be raised by the addition of bicarbonate of soda *(sodium bicarbonate, baking soda)*. Each 1.4 lbs. bicarbonate of soda per 10,000 gallons *(635.0 g per 37,854.1 L)* will raise total alkalinity approximately 10 ppm.

Too High

If total alkalinity is too high: pH becomes difficult to adjust. High pH often occurs causing other problems, such as cloudy water, decreased DISINFECTANT effectiveness, scale formation, and filter problems. The higher the total alkalinity, the more resistant the water is to large changes in pH in response to changes in the dosage of DISINFECTANT and pH correction chemicals.

Lowering Total Alkalinity

Add acid - The acid reacts with bicarbonates in the water and reduces the total alkalinity. Add 1.6 pounds of dry acid *(Sodium Bisulfate)* per 10,000 gallons of water, or 1.3 quarts of muriatic acid, to decrease the total alkalinity by 10 ppm. Retest and adjust the pH. High concentrations of CYA will cause interference in the total alkalinity test. This interference is magnified at low total alkalinity. To correct for CYA interference, measure the concentration of CYA, divide that number by 3, and then subtract that value from the measured total alkalinity value. Minor deviations from the alkalinity stated in the CODE do not in themselves present imminent health threats to the BATHERS. As such, minor deviations in alkalinity do not require the immediate closure of the facility. Rather, deviations from permissible alkalinity indicate poor management of the water balance and should indicate a need for a thorough inspection of the entire facility.

5.7.4.4.2 Combined Chlorine (Chloramines)

COMBINED CHLORINE compounds *(chloramines)* are formed when FAC combines with amine-containing compounds such as urea, amino acids, and ammonia from perspiration and urine. Chloramines include inorganic compounds *(monochloramine (NH_2Cl), DICHLORAMINE ($NHCl_2$) and TRICHLORAMINE (NCl_3))* as well as a variety of organic compounds. Inorganic chloramines are biocides but are less effective DISINFECTANTS than FAC. If the local water treatment plant uses chloramination for drinking water DISINFECTION, inorganic chloramines (predominantly monochloramine) might be present in the fill water.

High Chloramines

A high concentration of chloramines is undesirable in AQUATIC VENUES. The action concentrations for COMBINED CHLORINE is 0.4 ppm *(mg/L)*. Higher concentrations indicate that BATHER loads or pollution from BATHERS might be too high or that treatment is inadequate. Higher concentrations might also pose a health concern to BATHERS, other PATRONS, and staff. The World Health Organization recommends that COMBINED CHLORINE concentrations be "as low as possible, ideally below 0.2 mg/L."[56] However, this "ideal" concentration would be challenging to implement as a CODE requirement. Since the COMBINED CHLORINE values reflect the combination of inorganic *(well demonstrated health effects)* and organic *(poorly understood relationship to health effects)* chloramines, the MAHC has decided to work with an "action" concentration until they can be differentiated. Development of tests that can measure the inorganic chloramines separately from the organic chloramines is needed so actionable concentrations can be set. With such tests, aquatics staff will be able to respond to actionable concentrations of volatile chloramines so appropriate air quality can be maintained. The separate measurement of organic chloramines, which accumulate in the AQUATIC VENUE, might be a useful marker for the need to replace water or supplement with a system known to remove these compounds. Published data are limited but suggest that COMBINED CHLORINE concentrations are commonly above 0.2 ppm *(mg/L)* in swimming POOL water.[84, 274, 275]

Inorganic Chloramines

Volatilization of chloramine compounds can lead to strong objectionable odors in AQUATIC VENUE environments, as well as eye, mucous membrane, and skin irritation for BATHERS and PATRONS. Among the

inorganic chloramines, TRICHLORAMINE has the greatest impact on air quality, owing to its relatively low affinity for water and its irritant properties. TRICHLORAMINE has been reported to be an irritant at concentrations in water as low as 0.02 ppm *(mg/L)*.

Odors are unlikely to be present from inorganic chloramines below the following concentrations:

- Monochloramine (NH_2Cl): 5.0 ppm *(mg/L)*
- DICHLORAMINE ($NHCl_2$): 0.8 ppm *(mg/L)*
- TRICHLORAMINE (NCl_3): 0.02 ppm *(mg/L)*

Research to understand the relationship between inorganic chloramine concentrations in water and their impact on air quality is limited, although some research indicates that the gas phase TRICHLORAMINE concentration is dynamic and impacted by BATHER COUNT, BATHER activity, and liquid phase TRICHLORAMINE concentration. Reliable sampling and analytical methods affect the accuracy of the characterization of the AQUATIC VENUE water and air.

Health Incidents

Studies of swimming POOL users and non-swimming attendants have shown a number of changes and symptoms that appear to be associated with exposure to the atmosphere in indoor AQUATIC VENUES. CDC has investigated various health incidents reporting skin and eye irritation and acute respiratory illness outbreaks that could be associated with exposures to chloramines and other by-products at recreational water facilities, including swimming POOLS.[27, 33]

Lifeguard Exposure

For lifeguards at swimming POOLS, a dose–response relationship has been identified between TRICHLORAMINE, measured as total chloramines, and symptoms of eye, nasal, and throat irritation, although not chronic respiratory symptoms or bronchial hyper responsiveness.[86]

Respiratory Conditions

In addition to potential occupational exposures, there have been a number of studies investigating respiratory conditions, including asthma, related to swimming POOLS *(Also see MAHC 4.0.1.4.7)*. There appears to be no consistent association between swimming POOL attendance during childhood and the prevalence of asthma or atopic disease.[44-46, 48, 276] Studies indicate that asthma is more commonly found among elite swimmers than among other high-level athletes, although it is premature to draw conclusions about the causal link between swimming and asthma because most studies available to date used cross-sectional design, because the association is not confirmed among non-competitive swimmers, and because asthmatics might be more likely to select swimming as the activity of choice because of their condition.[276]

Contact Dermatitis

Chloramines have also been implicated in contact dermatitis *(rashes)*. The number of rashes that occurs among BATHERS in treated recreational water is not known. One cross-sectional study of Australian school POOLS retrospectively examined the incidence rate of rashes in three POOLS. The three POOLS treatment types were 1) CHLORINE alone *(hand dosing)*, 2) CHLORINE plus ozone *(automatic dosing and control)*, and 3) bromine *(sodium bromide plus ozone using automatic dosing and control)*. This study reported 14.4% of the BATHERS in the hand-dosed CHLORINE POOLS experienced rashes.[247] This and anecdotal reports strongly suggest that rashes are the most common RWI. The greatest number of rashes appears to be among hydro-therapists *(aquatic physical therapists)*. A survey of 190 professional hydro-therapists in Israel reported that 45% developed skin disease after beginning work. Symptoms reported included itchiness, redness, dry skin. The areas affected were the extremities, the face and trunk, and folds in the skin. The authors concluded: 1) exposure to water influences development of irritant contact dermatitis; 2) cumulative exposure of low-potency irritants might cause contact dermatitis; 3) contact dermatitis is an occupational disease of hydro-therapists.[246] In these and similar reports, the exact chemical species inducing the contact dermatitis has not been identified but the collective opinions of the investigators are that halogenated organic compounds are the cause. One conservative estimate places the number of halogenated DISINFECTION BYPRODUCTS *(DBPs)*, including organic chloramines, in swimming POOLS at greater than 200. The clinical significance of these is

likely to vary with the concentration of specific chloramine and BATHER specific factors *(e.g., length of exposure, underlying health conditions, and cumulative previous exposure)*.

Maximum Concentration

After considerable discussion, the recommended action concentration of 0.4 ppm *(mg/L)* for COMBINED CHLORINE in all recreational waters. As stated in MAHC 5.7.4.4.2, 0.4 ppm is an action concentration, not an absolute limit that would result in a violation. That is because the combined chorine measurement made in STANDARD test kits is a measure of all organic and inorganic COMBINED CHLORINE compounds in the water, not just the inorganic chloramines, DICHLORAMINE and TRICHLORAMINE, that are well documented to cause many of the health effects discussed above. Most of the organic CHLORINE compounds measured have little to no information about short or long-term health effects. This means that the COMBINED CHLORINE measured is a variable mixture of irritant compounds and other CHLORINE compounds not known to have these effects or without adequate health effects data. As a result, similar COMBINED CHLORINE concentrations could vary substantially in the amount of irritating inorganic chloramines in the mix. This makes it difficult to set a regulatory concentration for COMBINED CHLORINE or other related chemical measures until a test is available to differentiate the irritating inorganic chloramines from the remainder of the COMBINED CHLORINE mixture currently measured. The MAHC's interim solution decision was to move to an action concentration until such tests are available. The action concentration is then used to minimize the potential for both respiratory and dermal disease that is known to be associated with exposure to chloramines. The action concentration is intended to drive POOL operators to conduct regular COMBINED CHLORINE testing and use exceedances of the action concentration to implement a chloramine reduction plan. That means that failure to conduct regular COMBINED CHLORINE testing or exceeding the action concentration and having no plan for reducing the value would be the violation cited by inspectors rather than the actual exceedance of the COMBINED CHLORINE action concentration. The MAHC recognizes that the 0.4 ppm COMBINED CHLORINE concentration chosen is arbitrary and that it has not been substantiated by adequate human clinical studies. In the absence of an adequate human study, the MAHC has opted for a conservative value rather than a more lenient value of 0.5 ppm *(mg/L)* preferred by some operators. The key is that regulators start enforcing regular testing for COMBINED CHLORINE so that POOL operators work towards keeping concentrations low by responding to this action threshold. Concentrations of chloramines and other volatile compounds in water can be minimized by reducing introduction of CONTAMINANTS that lead to their formation *(e.g., urea, creatinine, amino acids, and personal care products)*, as well as by use of a shock oxidizer *(e.g., potassium monopersulfate)* or supplemental water treatment. Effective filtration, water replacement, and improved BATHER hygiene *(e.g., showering, not urinating in the POOL)* can reduce CONTAMINANTS and chloramine formation. Shock dosing with CHLORINE can destroy inorganic chloramines that are formed. Some research shows that non-CHLORINE shock oxidizers reduce the propensity to develop chloramines. However, this research has not been peer-reviewed to date. The EPA has determined that manufacturers of "shock oxidizers" may advertise that their "shock oxidizer" products "remove," "reduce," or "eliminate" organic CONTAMINANTS.

- For more information, see the EPA website: https://www.epa.gov/pesticide-labels/use-term-shock-swimming-POOL-hot-tubs-and-spa-products and https://www.epa.gov/sites/production/files/2015-06/documents/shock_addendum_final.pdf.

Secondary Treatment

SECONDARY TREATMENT such as ozone and UV might effectively destroy inorganic chloramines. As this also has a public health benefit and can assist in meeting the MAHC requirements for COMBINED CHLORINE, it is strongly recommended that any installation utilizing UV or ozone as a SECONDARY TREATMENT consider the positive impact the equipment can have on reducing COMBINED CHLORINE concentrations in addition to achieving DISINFECTION goals. To improve chloramine control strategies, future research should be aimed at:

- Defining the fundamental chemistry of DISINFECTION BYPRODUCTS including, organic and non-organic chloramine formation from precursor compounds that are common to swimming POOLS
- Defining relationships between concentrations of COMBINED CHLORINE in water and air of AQUATIC VENUES and the adverse effects on POOL attendees, to include inhalation, ingestion, and contact
- Documenting efficacy of water treatment technologies to reduce chloramine concentrations
- Improve testing for COMBINED CHLORINE in air and water

- Testing for the components of COMBINED CHLORINE.

5.7.4.4.3 Calcium Hardness

Calcium hardness is the amount of dissolved calcium *(plus some other minerals like magnesium)* in the water. Calcium hardness of 200−400 ppm *(mg/L)* is preferred for proper calcium carbonate saturation and for avoiding soft-water scale found in SPAS and hot tubs when other water parameters are near their nominal concentrations. For venues with water temperatures greater than 90°F *(32°C)*, the range should be 100−200 ppm. Too much calcium causes cloudiness and scale formation. Too little calcium, especially when combined with low pH or low total alkalinity can also lead to "aggressive water," which can dissolve calcium carbonate from plaster, as well as metallic parts of the POOL *(walls, floor, handrails, ladders, light FIXTURES, and equipment)*, and also cause discolored water or stains on the POOL walls and floor. The maximum permissible concentration of 2500 ppm *(mg/L)* might not be appropriate for regions with particularly hard source water. In such regions, local, state, territorial, federal, and tribal laws should reflect the specialized practices needed for source waters containing more than 2500 ppm *(mg/L)* total hardness. Deviations up to 300,000 ppm do not in themselves present imminent health threats to the BATHERS. As such, deviations in hardness concentrations do not require the immediate closure of the facility. Rather, deviations from permissible hardness concentrations indicate poor management of the water balance and should indicate a need for a thorough inspection of the entire facility.

5.7.4.4.4 Algaecides

In practice, most algaecides are reasonably effective when applied according to their EPA accepted label directions and the application is coupled with frequent and thorough brushing. CHLORINE and bromine can be registered and used as algaecides but must be used in accordance with EPA label directions. Bromine and bromamine have been demonstrated to be algaecidal.[277]

Common Types

The two basic types of non-halogen algaecides are copper-based algaecides and quaternary ammonia compounds *(QACs)*, often referred to as "quats." Some algaecides contain a mixture of a quat and a copper compound. Copper-based algaecides can be used to treat against all types of algae but are particularly effective against mustard and green types of algae. These will not cause foam to appear in a swimming POOL as is common with simple quaternary ammonia types of algaecides. There is however a problem with stains on the surface of the swimming POOL if the product is not used properly. Proper pH control is very important to minimize staining potential when using copper-containing algaecides. The other most common types are quaternary ammonium compounds. These algaecides will not stain a swimming POOL. There are two types of quats: simple and polymeric *(more commonly called "polyquats")*. Simple quats are mixtures of various alkyl dimethyl benzyl ammonium compounds *(ADBACs)* or didecyl dimethyl ammonium compounds *(DDACs)*. There are numerous variations of these. The technical name for the active ingredient in polyquats is "Poly *[oxyethylene (dimethylimino) ethylene (dimethylimino) ethylene dichloride]*." Neither type of quat will cause staining. When overdosed, simple quats tend to cause foam, especially in POOLS with water features *(e.g., fountains, waterfalls)*. Polyquats do not cause foaming, even when used repeatedly at the maximum label dose in POOLS with water features.

EPA–Registered Algaecides

In selecting a quat, it is vital that the product has been registered by the EPA for use in swimming POOLS. The vast majority, but not all, of the products on the market have current EPA registrations. All products registered by the EPA 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 which is managed for the EPA by Perdue University. As part of their registration process the EPA does not distinguish between public and private facilities.

- To access the EPA National Pesticide Information Retrieval System: (https://www.npirs.org/)

Registered Process

The EPA registration process for algaecides is substantially different than the registration process used for DISINFECTANTS. As part of the development of the product, the EPA requires companies to conduct efficacy

studies on the product. The EPA does not consider algae in POOLS or SPAS to be pathogenic and thus not a direct threat to public health. Since algae are not a public health issue, the EPA does not require companies to submit an efficacy package for an agency data review. Thus, in the registration process the EPA looks carefully at the toxicology of the product but not the efficacy. The state of California does require detailed efficacy studies prior to registration. Products sold in the state of California must have the state registration number on the label. Products registered in California but sold outside of the state usually have the California registration number on the label but are not required to do so. Any local, state, territorial, federal, and tribal agencies concerned about the efficacy of a particular algaecide could request the producer supply the California registration number and then verify the status of the product with the California Department of Pesticide Regulation (California Code of Regulations, Title 3. Division 6. Pesticides and Pest Control Operations).

5.7.4.5 Source (Fill) Water

Most public recreational water venues use the public water supply as the fill water source. In instances where this is not possible, it is important that the fill water not be a potential source of illness to BATHERS. Since requirements governing water quality vary by jurisdiction, it is not possible to specify every test that might be required by a jurisdiction. Therefore, facilities need to ensure that the fill water complies with the jurisdictional requirements. Examples of potential tests that a jurisdiction might require include, but are not limited to the following: bacteria, nitrates, nitrites, iron, manganese, sulfur, and turbidity. It is also recommended that this testing be conducted on an annual basis.

5.7.4.6 Water Balance for Aquatic Venues

Water balance is an important part of proper AQUATIC VENUE operation and maintenance. As such, the Langelier Saturation Index *(LSI)* is a useful tool for MONITORING the CORROSIVE or scale-forming tendencies of AQUATIC VENUE water. Although there is little scientific literature on the LSI and AQUATIC VENUE water, it is common industry practice to use this index.

The LSI formula is: LSI = **pH** + **TF** + **CF** + **AF** – **TDSF**

- **pH** Obtained by testing the AQUATIC VENUE water.
- **TF** Temperature Factor - using MAHC Annex Table 5.7.4.6 *(below)*, look up the actual AQUATIC VENUE water temperature at the time of sampling, to obtain the appropriate TF value.
- **CF** Calcium Hardness Factor - determine the ppm *(mg/L)* of calcium hardness *(CH)* in the water sample. Using the MAHC Annex Table 5.7.4.6 *(below)*, use the appropriate calcium hardness *(CH)* reading, to obtain the appropriate CF value.
- **AF** Total Alkalinity Factor - determine the ppm *(mg/L)* of total alkalinity (TA) in the water sample. Using the MAHC Annex Table 5.7.4.6 *(below)*, use the appropriate total alkalinity *(TA)* reading, to obtain the appropriate AF value.
- **TDSF** Total Dissolved Solids Factor – If the TDS of the water is less than 1,000 ppm *(mg/L)*, use the factor of 12.1. If the TDS of the water is greater than 1,000 ppm *(mg/L)*, use the factor of 12.2.

Note: Use the TF, CF, and AF factors closest to your actual reading.

Total Dissolved Solids

A generally accepted TDS in AQUATIC VENUES is 1,500 ppm *(mg/L)* above the TDS in the fill water. For AQUATIC VENUE using CHLORINE generators, startup TDS should be measured on the initial fill after adding the salt for the CHLORINE generator. Additional research needs to be done to determine TDS in saltwater AQUATIC VENUES, and its impact on water quality. TDS is a measure of the overall quantity of matter in the AQUATIC VENUE that is not water. This matter includes such things as minerals *(calcium, magnesium, etc.)*, chemicals, body oils, sunscreen, etc. that are not removed by filtration. There is only one state that has a maximum required TDS *(2,500 ppm (mg/L))*. However, there are no known scientific data that substantiates any value as a maximum. The 1,500 ppm *(mg/L)* concentration is utilized based on the fact that as the concentration of these materials increases in the AQUATIC VENUE, they can result in staining, cloudy water, decreased effectiveness of DISINFECTANTS *(by up to 50%)*, and an enhanced environment for the growth of algae. Excessively high TDS *(greater than 5,000 ppm [mg/L])* might require more drastic measures such as a

complete AQUATIC VENUE drain and refill, or additional water filtering, as a complete water drain might damage some AQUATIC VENUES. It is also important to note that the salt required by saltwater chlorination systems will substantially increase the TDS. Therefore, in saltwater AQUATIC VENUE, it is best to consider the TDS after the required amount of salt has been added to a freshly filled AQUATIC VENUE as the baseline.

Table 5.7.4.6 Langelier Index Conversion Chart

***TF*: Temp °F/°C**	***TF***	***CF*: CH ppm (mg/L)**	***CF***	***AF*: TA ppm (mg/L)**	***AF***
32°F / 0°C	0.0	5	0.3	5	0.7
37°F / 3°C	0.1	25	1.0	25	1.4
46°F / 8°C	0.2	50	1.3	50	1.7
53°F / 12°C	0.3	75	1.5	75	1.9
60°F / 16°C	0.4	100	1.6	100	2.0
66°F / 19°C	0.5	150	1.8	150	2.2
76°F / 24°C	0.6	200	1.9	200	2.3
84°F / 29°C	0.7	300	2.1	300	2.5
94°F / 34°C	0.8	400	2.2	400	2.6
105°F / 41°C	0.9	800	2.5	800	2.9
128°F / 53°C	1.0	1000	2.6	1000	3.0
—	—	1300	2.7	—	—
—	—	1600	2.8	—	—
—	—	2000	2.9	—	—
—	—	2500	3.0	—	—

Water balance should fall within the range of –0.3—+0.3, as determined by the Langelier Saturation Index.

*A **Low Langelier Index** (a value less than –0.3)* can result in corrosion, BATHER irritation, and discomfort. This AQUATIC VENUE water can cause etching, pitting, dissolving, and staining of walls, grouting, and plumbing.

LSI Decreases as:

- Stabilizer Increases, and
- Total Dissolved Solids Increase.

*A **High Langelier Index** (a value greater than +0.3)* can lead to scale formation, cloudy water, filtration problems, heater problems, loss of CHLORINE efficiency, and BATHER discomfort. AQUATIC VENUE water can deposit excess minerals on the POOL and equipment. Scale generally appears as white or lightly colored rough blotches on the AQUATIC VENUE walls. It also adheres to other objects in the POOL, piping, and filter system. Scale can restrict water flow, shortening filter runs and reducing filtration efficiency.

LSI Increases as:

- Temperature Increases,
- Total Alkalinity Increases,
- pH Increases, and
- Calcium Hardness Increases.

A small positive value is preferred over a negative value because a slight scale layer provides some protection, and is less harmful than corrosion, which causes permanent damage to mechanical and structural components.

Langelier Indexes can be adjusted to the -0.3—+0.3 range by:

- Adjusting the pH to 7.2–7.6, and

- Adjusting the total alkalinity to 60–180 ppm *(mg/L)*, and
- Adjusting the calcium hardness to
    - 200–400 ppm *(mg/L)* for a masonry POOL or SPA, or
    - 80–200 ppm *(mg/L)* for a vinyl or fiberglass unit.

While it is always possible to lower the pH, it is not as simple with the total alkalinity or calcium hardness. Lowering the total alkalinity will usually lower the pH as well. Lowering the calcium hardness is not always possible, given the variation in hardness of the fill water. In situations where the calcium concentration is high, attention should be paid to lowering the pH or total alkalinity to improve the LSI. It is not always possible to get the pH and total alkalinity within the proper range, due to the nature of the dissolved minerals. pH is the more important parameter and should be maintained within the proper range. If the AQUATIC VENUE is outdoors, and uses stabilized CHLORINE, it is recommended that 30% of the CYA reading be deducted from the total alkalinity test result to get a more accurate reading of the LSI.

5.7.4.7 Water Temperature

Specialized populations might require specific water temperatures for safe and effective programming. Some general guidelines are as follows:

- Cold water can affect both mental and bodily functions, possibly preventing clear thinking and restricting normal physical activity. It is uncomfortable, can be painful, and puts a strain on the body as you try to rewarm. Water below 70°F *(21°C)* is considered cold, since body heat is absorbed 25 times faster in water than air.
- Multi use AQUATIC VENUES are usually kept at 83–86°F *(28–30°C)*, while competitive AQUATIC VENUES are usually maintained at cooler temperatures between 78–82°F *(25.5–27.5°C)*. Depending on the target population, instructional and THERAPY POOL water temperatures usually range between 86– 94°F (30– 34°C).

The following table adapted from USA Swimming provides guidelines for water temperatures based on activity and population:

Table 5.7.4.7: Water Temperature Guidelines Based Upon Activity and Population

Bather Type	Temperature Range	Notes
Swim Team & Lap Swim	78°–82°F (25.5°–27.5°C)	Slightly warmer might be workable
Resistance Training	83°–86°F (28°–30°C)	---
Therapy & Rehab	91°–95°F (33°–35°C)	Can be as low as 87°F (30.5°C) for many types of therapy
Multiple Sclerosis	80°–84°F (26.5°–29°C)	Warmer water can cause adverse effects
Pregnancy	78°–84°F (25.5°–29°C)	Warmer water can cause adverse effects
Arthritis	84°–90° F (29°–32.2°C)	Arthritis Foundation min/max
Arthritis	86°–90°F (30°–32°C)	Aquatic Therapy and Rehabilitation Institute low function program
Fibromyalgia	86°–96°F (30°–35.5°C)	Aquatic Therapy and Rehabilitation Institute
Aerobic Activity	84°–88°F (29°–31°C)	---
Older Adults – Vertical	83°–86°F (28°–30°C)	Moderate to high intensity
Older Adults – Vertical	86°–88°F (30°–31°C)	Low intensity
Children, Fitness	83°–86°F (28°–30°C)	---
Children's Swim Lessons	82°F (27.5°C)	Varies with age and class length
Obese	80°–86°F (26.5°–30°C)	---

There are no definitive temperatures that are applicable for all uses of an AQUATIC VENUE. The suggested AQUATIC VENUE water temperature is dependent on the person's activity in the POOL. For example, individuals participating in competitive swimming prefer cooler water *(78°–82°F [25.6°–27.8°C])* than individuals participating in water fitness for arthritis *(83°F [28°C] minimum)* based on POOL temperatures

suggested by the Aquatic Exercise Association, see: https://aeawave.org/portals/0/aea_cert_docs/aea_standards_guidlines_2020.pdf?ver=2019-12-18-131623-417%C3%83%E2%80%94tamp=1576696862726. Water ranging in temperature from 79°–86°F *(26°–30°C)* is comfortable for most swimmers throughout prolonged periods of moderate physical exertion.(56) However, there are maximum temperatures that can and do have an effect on the health of the PATRON using the facility. Water temperature between 83°-86°F *(28°–30°C)* is the most comfortable temperature for typical recreational water usage. Water temperature may need to be adjusted based upon specific uses of the facility. The WHO recommends that water temperatures in hot tubs be kept below 104°F *(40°C)*. High temperatures *(above 104°F [40°C])* in SPAS or hot tubs can cause drowsiness, which may lead to unconsciousness and, consequently, drowning.(278) The CPSC has received reports of several deaths from extremely HOT WATER *(approximately 109°F or 43°C)* in hot tubs. In addition, high temperatures can lead to heat stroke and death. Further examination of data on the health impact of high temperature water on pregnancy, particularly in the first trimester, is needed. Minimum temperature requirements are not included in this CODE. Water that is too cold will not be utilized for any extended period of time and will not be used by individuals seeking a recreational water experience. Even though minimum temperatures are not included in the CODE, it is important to remember that cold-water basins, such as plunge POOLS, can present health concerns due to water temperature extremes. These small, deep POOLS generally contain water at a temperature of 46–50°F *(7°–10°C)* and are used in conjunction with saunas or steam baths. Adverse health outcomes that can result from the intense and sudden changes in temperature associated with the use of these POOLS include immediate impaired coordination, loss of control of breathing and, after some time when the core body temperature has fallen, slowed heartbeat, hypothermia, muscle cramps, and loss of consciousness. In general, exposure to temperature extremes should be avoided by pregnant women, users with medical problems, and young children.(56)

Spa Temperature Maximum

SPA temperature maximum was based on the preponderance of state CODES that currently use this temperature and it is widely accepted and practiced in the industry. See discussion below in MAHC Annex 5.7.4.7.2 that recommends further evaluation.

Comfortable

Water varying from 83°–86°F *(28°–30° C)* is the most comfortable temperature for typical water fitness classes. This allows the body to react and respond normally to the onset of exercise and the accompanying increase in body temperature. Cooling benefits are still felt and there is little risk of overheating. Program modifications will be required for water temperature outside the recommended range. Aquatic fitness professionals should know the water temperature and modify the program accordingly based upon the population and the program format.

Below Recommendation

Water temperature below the recommended range requires modifications in programming. The primary focus of the warmup should be large, lower impact, rhythmic movements that gradually elevate core temperature of the body and should last for at least 9–15 minutes. The main segment must be of adequate intensity to maintain proper body temperature and prevent injury. Participants might find it necessary to wear specialized clothing to maintain body heat. The cool down and post-stretch must be adjusted, in overall length as well as activity, according to the environmental conditions. Water temperature above the recommended range also requires modifications in programming. The intensity and length of the main segment should be adjusted to prevent overheating. Encourage proper hydration and apparel *(e.g., avoid swimming caps that prevent heat dissipation)*. An extended cool down with emphasis on stretching and relaxation is appropriate.

5.7.4.7.2 Maximum Temperature

SPA temperatures of 104°F *(40°C)* are routinely used in SPAS and hot tubs across the United States. The MAHC is not aware of data that suggests this is too high for use by healthy individuals. Higher temperatures mimic a high fever in the human body and might not be healthy, particularly for prolonged use. However, the high temperature used in SPAS and hot tubs *(MAHC sets it at 104°F [40°C] maximum)* necessitates signage with strong wording to alert users about alcohol use and alert vulnerable groups about the risks potentially

associated with use of SPAS and hot tubs. Review of the existing data *(or collection of new data)* is needed to inform the MAHC about whether a maximum length of time in a SPA should be set.

Ethanol Use and Solo Use

Ethanol use can contribute to the likelihood of drowning[279]. Low to moderate doses of ethanol did not appear to significantly impact body temperature or thermoregulatory response systems in healthy males at 104°F *(40°C)*[280, 281]. However, there did appear to be increased risk of cardiac hypotension and fainting when users stood up that could result in slips or falls, the most common cause of spa-related injury in the United States[282]. Several studies of sauna-related deaths in Scandinavia find a high percentage of alcohol use and that users were alone[283, 284]. Signage to restrict alcohol use, not to use SPAS when alone, and to exercise caution and use handrails to exit is warranted.

Pregnant Women

Maternal hyperthermia has been shown to be associated with birth defects[285]. Some studies have shown an increased risk of birth defects and miscarriages associated with hot tub or SPA use during early pregnancy(286-289). Pregnant women, particularly during the first trimester, should consult their healthcare provider before using hot tubs or SPAS. If women in later pregnancy choose to use hot tubs or SPAS, they should keep exposure to a minimum, and ensure the temperature is at or below recommended STANDARDS. Signage should alert pregnant women about the potential risks of hot tub or SPA use and the need to consult with their healthcare provider before use. Further expert review of the data is warranted to see if the data support reducing the water temperature and, if so, what temperature should be adopted to proactively protect women of childbearing age who might not know if they are pregnant.

Young Children

High temperatures can put great demands on the circulatory system. The few studies exist looking at the impact of high temperature on young children although older children do appear to be able to control their temperature as well as adults.[290] . However, infants cannot control their body temperature as effectively as their older siblings[291] and parents. This is because babies have a small body mass compared to body surface area. Being in water even a few degrees different from normal body temperature *(98.6°F [37°C])* can affect a baby's body temperature. Being in very warm or HOT WATER found in hot tubs/SPAS can cause hyperthermia, a dangerously high body temperature. Signage for SPAS and hot tubs should caution users about bringing infants and young children into SPAS or hot tubs, particularly for a prolonged time.

5.7.5 Water Quality Chemical Testing Frequency

Table 5.7.5: Water Testing Frequency Reference Chart

Chemical	Start-up*	Manual Testing	Automated Controllers	Closing*
Free Chlorine	Yes	2 hrs.	4 hrs.	Yes
Combined Chlorine	Yes	2 hrs.	4 hrs.	Yes
pH	Yes	2 hrs.	4 hrs.	Yes
Total Alkalinity	Yes	-	-	-
Calcium Hardness	Yes	Monthly**	-	-
CYA	Yes	Once per week†	-	Yes**
TDS	Yes	-	-	-

Note: Microbiological testing shall be conducted after a fecal incident.

Note: Manual testing should be done after a major weather event for outdoor facilities.

* Manual testing to be done at these times.

**Minimum monthly testing at all AQUATIC VENUES utilizing CYA

† AQUATIC VENUES using CHLORINE stabilizer *(e.g., stand-alone CYA, trichlor [trichloro-s-triazinetrione] or dichlor [sodium dichloro-s-triazinetrione])*.

5.7.5.1 Chemical Parameters

When using colorimetric testing methods, COMBINED CHLORINE testing consists of measuring free CHLORINE, measuring total CHLORINE, and subtracting the free CHLORINE from the total CHLORINE. When using titrimetric methods, it is easiest to perform a direct measure. The analyst should simply count each drop of titrant and multiply by the correct factor to attain the COMBINED CHLORINE concentration. A properly calibrated automatic chemical MONITORING system which maintains records and can be MONITORED remotely via a secure website could be acceptable for daily testing, if the system allows for the health department to have access to view a read-only log which MONITORS the chemistry at a facility.

5.7.6 Water Clarity

Water clarity is a useful measure of general water quality. Visual observation of main drains *(i.e., BATHER visibility)* is important for BATHER SAFETY to prevent drowning and other injuries. For POOLS, the use of a Secchi disk is not recommended. If a reference tile or suction outlet is not available, an alternate means of measuring clarity, such as a submersible manikin or shadow doll, could be placed at the deepest point of the POOL/attraction to check clarity. For more information about the limitations of Secchi disks, see NOAA Technical Memorandum ERL PMEL-67.

5.8 Decks and Equipment

5.8.1 Deck Areas

ANSI defines where a trip hazard is considered as a level change that is greater than ¼ inch *(6.35 mm)*. Other definitions include an abrupt or unexpected level change in surfaces.

5.8.1.2.3 Tripping Hazards

Over time changes might occur in DECK elevation or equipment added to or removed from the DECK surface. The DECK should be inspected to ensure any changes in DECK elevation or the addition or removal of DECK equipment does not cause a tripping hazard.

5.8.2 Diving Boards and Platforms

5.8.3 Starting Platforms

See MAHC Annex 4.8.3 for discussion.

5.8.4 Pool Slides

5.8.5 Lifeguard and Safety Related Equipment

5.8.5.1 Equipment Inspection and Maintenance

The absence of this required equipment can adversely affect the effectiveness of a rescue and the SAFETY of the lifeguard. It could also hinder the response from emergency services. For this reason, it is the responsibility of the owner/operator to make sure this equipment is in place prior to opening the AQUATIC FACILITY to the public. The equipment should be working so it can be used when needed. The word "safe" denotes the equipment is not modified to be in working condition and thus pose a risk to the user.

5.8.5.2 Safety Equipment Required at All Aquatic Facilities

5.8.5.2.1 Emergency Communication Equipment

5.8.5.2.1.1 Functioning Communication Equipment

As stated in the design section, emergency communication devices should be part of the design but also required to be present in the operation.

5.8.5.2.1.2 Hard Wired Telephone for 911 Call

- The AQUATIC FACILITY must be provided with the tools necessary for rapid and effective emergency communication. These tools might include a telephone, emergency band radio or other effective means of communication.

- Having a reliable telephone available during an emergency is important. Frequently cellular telephones, cordless telephones, and other self-powered devices are not ready for use. Having a hard-wired telephone provides that reliability.
- The telephone must be available to all AQUATIC VENUE users for use in an emergency, anytime the AQUATIC VENUE is open for use. Pay telephones must be able to dial 911 without the use of coins or cards and maintained in an operable condition.
- The communication device should be placed in a manner where BATHERS can see and reach the device within about 1 minute and be placed so there are no obstructions to reaching it. The response time by the proper emergency agency has been shown to make a difference in patient outcome.[291]

5.8.5.2.1.4 Alternate Communication Systems

The intent is that an emergency phone or alternate communications system or device is immediately available to PATRONS from all AQUATIC VENUES within an AQUATIC FACILITY. Some alternate communication systems might include a handset or intercom system to a location that is constantly manned whenever the AQUATIC VENUE is open for use *(e.g. a front desk at a hotel, the check in desk at a fitness club, or other continuously manned location)*; a commercial emergency contact device that connects to a MONITORING service, or directly to 911 dispatch; or devices that alert multiple staff onsite when activated *(e.g. pagers systems, cellular telephone systems and radio communication alert systems)*. For larger facilities, this could include internal communication processes such as two-way radio communication to a central phone to facilitate emergency communications to outside EMS in place of hard wired publicly accessible phones.

5.8.5.2.2 First Aid Equipment

5.8.5.2.2.1 Location for First Aid

This is stated in the design section but also stated in the MAHC operations section to require the operator to designate a first aid location for existing facilities. The supplies should be provided at locations where they can be quickly accessed when responding to emergencies.

5.8.5.2.2.2 First Aid Supplies

The first aid supply list is based on ANSI/ISEA Z308.1 for a Workplace First Aid Basic Kit. The listed contents are based on the items needed, but the quantities are not specified to allow for flexibility based on the size of the AQUATIC FACILITY, the anticipated BATHER COUNT, anticipated number and types of injuries, and the number of first aid locations. Topical supplies such as antibiotic cream, burn gels, and antiseptics were removed because this poses a scope of practice issue for the level of training typical to lifeguarding. The operator should provide enough supplies that the kit does not need continuous restocking. There should be enough supplies to last between first aid kit supply inspections, plus the time needed to obtain and replace the supplies. The contents should be inspected and resupplied often enough to maintain the supplies in good condition. The supplies must be stored in such a manner as to protect them from moisture and extremes of heat and cold that will cause deterioration. Supplies must be periodically checked for expiration dates and replaced as needed. A biohazard cleanup kit was included as lifeguards often deal with body fluids on surfaces such as vomit, feces, and blood. According to OSHA[292], "Generally, lifeguards are considered to be emergency responders and, therefore, would be considered to have occupational exposure. Emergency response is generally the main responsibility of lifeguards; therefore, such duties could not be considered collateral. Although it is the employer's responsibility to determine which, if any, of the employees have occupational exposure, employers of lifeguards should examine all facets of the lifeguard's emergency response duties, not just "retrieval from deep water." As a result, lifeguards are covered under OSHA 29 CFR 1910.1030 Bloodborne Pathogens Standard, which speaks to having contact with individuals that might be injured and bleeding. As a result, employers are required to offer all the protections of the Bloodborne Pathogens Standard. Management should also consider how bloodborne pathogen training is integrated with training for surface or water-based clean-up of feces and other body fluids *(See MAHC 6.5).* The MAHC chose to compile this list after reviewing the contents of several kits that were commonly available. One complete bloodborne pathogen spill kit is needed at the AQUATIC FACILITY. Example of minimum suggested contents:

- Disposable gloves*

- Disposable gown or apron, facemask, shoe covers
- Face shield
- Anti-microbial wipes
- Biohazard bag
- DISINFECTANT *(ex. calcium hypochlorite packet – 1 oz.)*
- Absorbent materials or fluid solidifier *(~20 gm)*
- Scoops for solidified material
- Scraper
- Instructions for use

* Do not use latex gloves due to the potential for allergies. Gloves should be single use, vinyl or nitrile, and non-powdered. Gloves should be disposed of after one use. Fit is important. It is recommended that 4 to 6 mil. gloves be used.

It is suggested that a kit be assembled, put in a container, and sealed to ensure the contents are still intact when needed. After use, a new kit is provided, or the container is restocked and resealed.

In addition to the AQUATIC FACILITY kit, lifeguards should carry basic PPE for immediate use during initial exposure to feces, vomit, and small amounts of blood until the full kit arrives at the treatment scene. AEDs were considered to be included in this list, but due to the requirement for medical direction for AED use by trained rescuers, it was not included as it might not be within the AHJ's authority to mandate such equipment. However, AEDs are widely used and can be used for submersion events and any cardiac incident. If local protocols can be established, it is recommended to have an AED.

5.8.5.2.3 Signage

5.8.5.2.3.1 Sign Indicating First Aid Location

Effective signage must communicate where first aid assistance can be obtained. This is especially important in smaller AQUATIC FACILITIES and at AQUATIC FACILITIES not requiring lifeguards where the first aid station might be outside the immediate AQUATIC VENUE area. Signage is also important at very large AQUATIC FACILITIES where the first aid station might be harder to find. Effective signage should follow the STANDARDS established by ICC A117.1 and ADA Accessibility Guidelines including sign height, raised or Braille lettering, and placement. Emergency telephones or communication devices are usually in conspicuous locations; however, those locations should be communicated so BATHERS and staff alike so they know where they can rapidly locate them.

5.8.5.2.3.2 Emergency Dialing Instruction

Signage must be posted at the telephone or approved communication system or device with emergency contact number*(s)* or procedures and the address of the AQUATIC FACILITY. Often a person in an emergency can be confused, so having the address of the AQUATIC FACILITY, emergency number*(s)*, and special instructions, if any, at the telephone makes responding easier.

5.8.5.2.3.3 Management Contact Info

An owner/operator contact number must be provided for notification of water quality and SAFETY concerns. At AQUATIC FACILITIES where QUALIFIED OPERATORS are not present at all times, it is important for PATRONS to be able to contact the owner/operator when water quality has been compromised *(e.g., cloudy water, fecal matter in the water, or other issues of concern related to water quality or SAFETY)*.

5.8.5.2.3.4 Hours of Operation

Operating hours for an AQUATIC FACILITY should be posted and clearly visible at the AQUATIC FACILITY, especially when the AQUATIC FACILITY is not attended at all times by an operator or lifeguard.

5.8.5.3 Safety Equipment Required at Facilities with Lifeguards

5.8.5.3.1 UV Protection for Chairs and Stands

In MAHC 4.8.5.3.3, permanently installed chairs and stands are required to be designed with UV protection. In MAHC 5.8.5.3.1, chairs and stands are required to have the UV protection present. Regardless of when the

chair or stand was constructed, UV protection is required to protect the lifeguard from an occupational exposure.

5.8.5.3.2 Backboard

Backboards facilitate extrication of unresponsive victims and immobilization and extrication of a person with a suspected spinal injury. Because these backboards are often used in or around the water, their construction should be of materials that can withstand the environment and be easily SANITIZED/disinfected between uses. Backboards must be properly maintained and in good repair. For example, a wooden backboard that is worn so the wood is exposed and no longer cleanable. In this case, refinishing it with a waterproof finish should again make it cleanable. Additionally, the head immobilizer and straps are used for spinal injury management. These tools assist in the immobilization of a person on the backboard and should be present during operation. When deciding which straps to be included, one should consider how to best immobilize the person to the backboard. Common locations for straps are at the upper torso, the hips, and legs. The number of backboards available at the AQUATIC FACILITY should be dependent on the size of the AQUATIC FACILITY and allow for a quick access to the backboard*(s)*. It might be difficult to determine the exact number, but the MAHC requires that a backboard reach any area of any zone of surveillance within 2 minutes. There should not be a delay in care for the person needing to be extricated from the water.

5.8.5.3.3 Rescue Tube Immediately Available

The 50th percentile adult is at least 64 inches *(1.6 m)* tall. The rationale is that the average adult BATHER's head would be above the static water line and they could use the AQUATIC VENUE without difficulty. Due to buoyancy considerations at chest level, a short lifeguard could have difficulty doing a rescue safely without equipment. For this reason, the rescue tube is required unless there is less than 3 feet *(0.9 m)* of depth in which their chest would likely be above the static water line. Lifeguard training agencies have determined that the use of a rescue tube makes rescues safer for both the victim and the rescuer. The rescue tube provides a BARRIER between the victim and the rescuer as well as a handhold for both during a rescue. In very shallow water, the rescue tube might not be as effective so the language in the CODE is flexible to allow for the rescue tube to be available immediately but is not required to be worn. However, as stated above, the rescue tube provides protection for the lifeguard so the operator should determine the level of risk and requirement for wearing the rescue tube based on the AQUATIC VENUE depth, activities, and frequency of rescue.

5.8.5.3.4 Rescue Tube on Person

Being properly prepared to respond to an emergency requires wearing the harness strap attached to the rescue tube and keeping the rescue tube in a position and location where it can be immediately used. It is important to wear the rescue tube in a rescue ready position. Wearing the strap and sitting with the tube at the lifeguard's feet, or in any other position except held against the body, can lead to situations where a lifeguard is injured or cannot respond because the tube's strap is wrapped around handrails, chair pedestals or other catch points. Management should reinforce through pre-service, in-service, and employment policy that the lifeguards are expected to hold the rescue tube in a manner taught and accepted by the lifeguard training agency.

5.8.5.3.5 Identifying Uniform

There should be no delay in care because a PATRON is unable to find a member of the AQUATIC FACILITY SAFETY TEAM. Distinct uniforms are a STANDARD in most industries to identify workers and their assigned tasks.

5.8.5.3.6 Signal Device

The most basic communication method used by lifeguards is a combination of whistle blasts and hand signals to communicate with each other, PATRONS, and management. Whistle signals can communicate when to clear the POOL, get another lifeguard's or supervisor's attention, and communicate emergencies. The devices and their use can vary depending on the AQUATIC FACILITY and its management. Because of inherent BACKGROUND NOISE, whistles, hand signals, emergency buttons, radios, and telephone handsets are used to provide more effective communication.

5.8.5.3.7 Sun Blocking Methods

Protection from direct sun exposure is a necessary part of lifeguarding at AQUATIC FACILITIES. Gone are the days when the objective of the lifeguard was to get as deep a tan as possible. Today, sun exposure, especially when the skin becomes burned, increases significantly the risk of skin cancers. In a recent study of melanoma, it was noted that the melanoma DNA contained 33,000 mutations, many of which may have come from UV light exposure[293]. The best sunscreens available at the present time are broad spectrum or full spectrum and are usually so labeled. More will probably become available as new Food and Drug Administration rules are implemented[294]. These protect against both UVA and UVB rays as long as re-application is conducted periodically. Because SPF ratings only measure UVB effectiveness there is a lot of variability in UVA protection in sunscreens. CDC recommends a sunscreen with an SPF of at least 15.[295] There are some questions about the health effects of some of the screening chemicals, but the benefits seem to outweigh the hazards. To minimize exposure to these chemicals, lifeguards should also wear protective clothing, hats, use sun-blocking umbrellas, or any other means to avoid exposure to UV light. Protection is also needed from reflected exposure. Light-skinned individuals can be particularly sensitive to both direct as well as indirect exposure to the sun's UV rays[296]. Employers should educate lifeguards about the risk and protection options but are exempted from requirements to pay for sunscreen as PPE according to OSHA 29 CFR 1910.132(h)(4)(iii).[297]

5.8.5.3.8 Polarized Sunglasses

Glare and reflected sunlight off the water surface can cause substantial visibility problems for lifeguards and potentially impact job performance. Lifeguards working at outdoor AQUATIC VENUES are required to wear polarized eye wear to reduce the risk of glare causing reduced visibility. This polarized eyewear should also be a part of any sun exposure awareness training since it also potentially reduces the harmful short- and long-term effects of UV on eyes that include increased risk for cataracts and macular degeneration[298-304]. However, employers are exempted from requirements to pay for sunglasses as PPE according to OSHA 29 CFR 1910.132(h)(4)(iii)[298]. Polarized eyewear can assist with glare indoors as well but should be tested so it does not impede visibility due to lower light levels. Polarized 3-D glasses must not be used as they can be disorienting and can disrupt normal vision.

5.8.5.3.9 Personal Protective Equipment

Appropriate PPE must be provided to all employees that have possible occupational exposures. On-duty QUALIFIED LIFEGUARDS should carry basic PPE *(disposable gloves and resuscitation mask with one-way valve)* or have it attached to the rescue tube, so it is available for immediate use during in-water unconscious rescues. This should prevent delay in appropriate care and for protection during initial exposure to feces, vomit, and small amounts of blood until the full facility bloodborne pathogen kit arrives at the treatment scene. This PPE could be in a small pouch to be carried on the lifeguard or in a pouch associated with the rescue tube. The intent is that the lifeguard does not need to leave the immediate area to find PPE, creating a delay in response.

OSHA Bloodborne Pathogen Regulations[305], require that the employer shall provide, at no cost to the employee, appropriate PPE such as, but not limited to, gloves, gowns, face shields or masks and eye protection, and mouthpieces, resuscitation bags, pocket masks, or other ventilation devices. PPE will be considered "appropriate" only if it does not permit blood or other potentially infectious materials to pass through to or reach the employee's work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used.

NOTE: The Food and Drug Administration *(FDA)* issued a rule banning powdered gloves that became effective on January 18, 2017. FDA determined that Powdered Surgeon's Gloves, Powdered Patient Examination Gloves, and Absorbable Powder for Lubricating a Surgeon's Glove present an unreasonable and substantial risk of illness or injury and that the risk cannot be corrected or eliminated by labeling or a change in labeling. Health effects documented include inflammation, granulomas, and respiratory allergic reactions. The full rule can be accessed at https://www.federalregister.gov/documents/2016/12/19/2016-30382/banned-devices-powdered-surgeons-gloves-powdered-patient-examination-gloves-and-absorbable-powder.

5.8.5.3.10 Rescue Throwing Device

If the single lifeguard is engaged in a rescue and another person is in distress, the rescue throw device allows for an untrained individual to assist the distressed person.

5.8.5.3.11 Reaching Pole

If the single lifeguard is engaged in a rescue and another person is in distress, the reaching pole allows for an untrained individual to assist the distressed person.

5.8.5.4 Safety Equipment and Signage Required at Facilities without Lifeguards

5.8.5.4.1 Throwing Device

A rescue throwing device is a throw bag, buoyant life ring, torpedo buoy or other easily thrown buoyant device that is designed for a person on the DECK to throw to a person in distress in the AQUATIC VENUE. A 50-foot *(15.2 m)* minimum of ¼ inch *(6.4 mm)* rope securely attached to the device is required. It has been found that untrained individuals have a reasonable ability to reach 30 feet *(9.1 m)* with a rescue throw device. A 50-foot *(15.2 m)* rope would accommodate that distance. The 1.5 times the width of the POOL allows for a SAFETY factor to overthrow the device and pull the rope back toward the person in distress. This also allows for extra rope to hold on to. The device must be kept ready for use, and the rope must be coiled to prevent tangles and to facilitate throwing the device.

5.8.5.4.2 Reaching Pole

The pole is intended to reach out to a swimmer in distress and to allow them to grab hold of the pole. The pole should be submerged when introducing it to the swimmer to prevent injury. In some cases, the "hook" can be used to encircle a non-responsive swimmer to draw them to the side. Use of the device involves reaching out to the swimmer and then pulling the pole straight back to the side, along with the swimmer. The pole cannot be swung around to the side as the strength required exceeds that of most people, and the pole is not that durable. Since the pole is pulled back to the side, a telescoping pole is not appropriate as it can pull apart. Ideally the pole can reach to the middle of many smaller POOLS making the entire POOL reachable from the side with the pole. The pole must be equipped with a "life-hook" or "shepherd's crook." For SAFETY, the hook must be a looped frame-type hook, not the single metal hook. The hook protects the swimmer from being injured by the pole, as well as allows a non-responsive swimmer to be pulled in. To prevent injury, use only the hook attachment bolts supplied by the manufacturer. This will prevent hooks and snags, caused by using the improper bolts, which can injure the swimmer.

5.8.5.4.3 CPR Posters

CPR performed by bystanders has been shown to improve outcomes in drowning victims[306]. CPR started immediately on a drowning victim instead of waiting until emergency responders arrive will have a significant effect on the potential for brain damage in the victim. Posters of CPR explaining basic procedures can be reviewed in seconds and give the provider enough knowledge to assist the victim until emergency responders arrive. Posters can educate PATRONS about the pathogens that cause RWIs, how these pathogens are transmitted, and how to prevent their transmission. PATRONS need to be educated about these topics because they can introduce pathogens into the water.

Resources for RWI education can be found at https://www.cdc.gov/healthy-swimming/. Many resources for CPR posters can be found online.

5.8.5.4.4 Imminent Health Hazard Sign

A sign indicating reasons requiring closure especially at AQUATIC FACILITIES where a QUALIFIED OPERATOR or QUALIFIED LIFEGUARD is not present should be posted listing specific incidents which would require the AQUATIC FACILITY to immediately close. Examples of such incidents include fecal incidents, broken/missing drain grates, water clarity, water quality issues, and lightning. A contact number should be provided to notify the owner/operator of conditions considered an IMMINENT HEALTH HAZARD.

5.8.5.4.5 Additional Signage

MAHC 6.3.2 outlines the conditions that require a QUALIFIED LIFEGUARD. For AQUATIC FACILITIES that do not have lifeguards, PATRONS should be informed that no lifeguard is provided so they can comply with any requirements and understand the identified risk. For instance, at a hotel POOL that requires key entry, the sign

would notify hotel guests that no lifeguard is provided and persons under the age of 14 years are not allowed in without adult supervision.

5.9 Filter/Equipment Room

In a review of POOL chemical incidents documenting 400 incidents, 221 reported two contributing factors. Of the 221 secondary factors, 39.8% listed improper chemical mixing as one of the contributing factors.[206]

5.9.1 Chemical Storage

5.9.1.1 Codes

All chemical containers must be labeled with the following information:

- Chemical identity,
- Manufacturer's name and address,
- Physical hazards,
- Health hazards, and
- Degree or type of risk.

The label should explain necessary precautions to take; how to handle, store, and dispose of chemicals; and sometimes indicate hazard potential with a number 0–4. This number indicates the degree of risk, with the number 4 representing the greatest risk, and shows the hazard categories *(see NFPA 704)*.

5.9.1.2 OSHA and EPA

Chemicals should never be pre-mixed with water by hand before adding the chemical to the AQUATIC VENUE unless specified by the manufacturer. If a dissolution or feed tank is used to dissolve product for feeding into the AQUATIC VENUE, the tank must be equipped with a mechanical mixer, dedicated to a single chemical, and clearly labeled to prevent the introduction of incompatible chemicals to the tank.

Chemicals should be added to water, water should never be added to chemicals.

Pre-mixing in containers that are not clean can result in the generation of heat and toxic gases and may result in fire or explosion. Oxidizers such as calcium hypochlorite, monopersulfate, or bleach shall not be mixed with any other chemicals.

5.9.1.3 Safety Data Sheets (SDS)

An SDS is a form containing data, potential hazard information, and instructions for the safe use of a particular material or product. As an important component of product stewardship and workplace SAFETY, an SDS is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner. This includes information such as physical data *(melting point, boiling point, flash point, etc.)*, toxicity, health effects, impact on the environment, first aid, reactivity, STORAGE, disposal, protective equipment, and spill handling procedures. The exact format of an SDS can vary from source to source. It is important to use an SDS that is supplier specific as a product using a generic name *(e.g., oxidizer)* can have a formulation and degree of hazard which varies between different manufacturers.

Filed

SDSs should be filed anywhere chemicals are being used. An SDS for a substance is not primarily intended for use by the general consumer, focusing instead on the hazards of working with the material in an occupational setting.

OSHA

In the U.S., OSHA requires that SDSs be available to employees for potentially harmful substances handled in the workplace under the Hazard Communication regulation (29 CFR 1910.1200). The SDS is also required to be made available to local fire departments and local, state, territorial, federal, and tribal emergency planning officials under Section 311 of the Emergency Planning and Community Right-to-Know Act *(EPCRA)*.

Hazard Ratings

The SDS will typically contain the hazard ratings according to either NFPA 704 or HMIS systems. The NFPA system may be found in NFPA 704: STANDARD System for the Identification of the Hazards of Materials for Emergency Response. In the NFPA system, the chemicals are rated according to their health, flammability, instability, and special hazards. The degree of hazard is indicated by a number from 0 to 4, with 0 being the least hazardous and 4 being the most hazardous. Either HMIS or NFPA ratings are useful to include on product labels. Most fire CODES require these ratings to be posted on chemical STORAGE room doors.

5.9.1.5 Protected

In addition to the requirements listed in MAHC 5.9.1.5, the following BEST PRACTICES are recommended:

- Place all chemical containers, drums, boxes, and bags on pallets to raise them off the floor.
- Containers should not be stacked so that they will easily fall over. A general rule of thumb is that they should not be stored more than three high.
- Containers of chemicals shall be closed securely to prevent contamination.
- Any shelving units used to store chemicals should be sturdy enough to support the weight of the chemicals being stored.

5.9.1.6 No Mixing

Particularly keep chlorinated cyanurates, hydantoin bromine, and calcium hypochlorite away from other chemicals, paper, water, petroleum products, or other organic compounds to avoid possible cross-contamination. No liquids should be stored above solids. Chemicals must be stored in the original manufacturers' labeled container. STORAGE containers that held other chemicals previously are unacceptable. Chemicals may be transferred from the original container to a new container if that container was manufactured for the STORAGE of that chemical and properly labeled. Aquatics staff should read and consider findings and recommendations developed from investigations related to POOL chemical-related injuries.

- See CDC Pool Chemical Safety accessed at https://www.cdc.gov/healthy-swimming/toolkit/pool-chemical-safety.html.

5.9.1.7 Ignition Sources

NFPA, HMIS, or equivalent hazard rating systems may be used.

5.9.1.9 Lighting

Horizontal-plane illumination must be adequate for SAFETY and navigation, as well as for reading documents.

The IESNA recommends a 30 footcandle *(323 lux)* minimum for Motor & Equipment Observation.

5.9.1.10 Personal Protective Equipment

Common components of PPE for chlorinated AQUATIC VENUE chemicals are as follows:

- **Respiratory Protection**: Wear a NIOSH approved respirator if concentrations above the exposure limits are possible.
- **Respirator Type**: A NIOSH approved full-face air purifying respirator equipped with combination CHLORINE/P100 cartridges. Air purifying respirators should not be used in oxygen deficient or IDLH atmospheres or if exposure concentrations exceed ten times the published limit.
- **Skin Protection**: Wear impervious gloves to avoid skin contact. A full impervious suit is recommended if exposure is possible to a large portion of the body. A SAFETY SHOWER should be provided in the immediate work area.
- **Eye Protection**: Use chemical goggles. Emergency eyewash should be provided in the immediate work area.
- **Protective Clothing Type**: Neoprene, Nitrile, Natural rubber *(This includes gloves, boots, apron, protective suit)*.

5.9.3 Chemical Handling

5.10 Hygiene Facilities

5.10.1 General

5.10.2 Location

5.10.3 Bathhouse Design

5.10.4 Plumbing Fixture Requirements

5.10.4.1 General Requirements

Toilets and SHOWERS should appear clean and ready to use to attract BATHERS to use them[116]. Although the MAHC is not aware of any work in this particular setting, studies in childcare settings, schools, long term care facilities and food service establishments all support the importance of surface cleaning. The MAHC feels that daily cleaning at a minimum in this setting is reasonable for aesthetics as well as health and SAFETY. It is important to both clean and SANITIZE *(or disinfect)* HYGIENE FACILITY surfaces. EPA regulates all products, including surface cleaning products, that kill germs (https://www.epa.gov/pesticides). Therefore, when sanitizing or disinfecting HYGIENE FACILITY surfaces, an EPA–REGISTERED product must be used. The general term used by EPA is "pesticides" which are defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pests include harmful microorganisms such as bacteria, viruses, and mold. During the registration process for pesticides, EPA considers both the ecological and human health risks of products as well as their efficacy. Consideration can also be given to the overall environmental impacts that these cleaning products have. UL 2759 is a publicly available STANDARD that establishes human health and environmental criteria for hard surface cleaners. This STANDARD is designed to reduce environmental impacts by specifying criteria for safer chemicals and materials, use of recycled and recyclable materials, and minimizing pollution generated by the production, use, and disposal of these products and their packaging.

5.10.4.3 Rinse Showers

Soap is not needed at RINSE SHOWERS because it can have a negative effect on water chemistry.

5.10.4.5 Diaper-Changing Stations

It is the responsibility of PATRONS to clean diaper-changing surfaces after each use. This is consistent with practice in other public settings where diapering takes place. However, staff should keep an eye on stations and clean when necessary.

5.10.4.6 Non-Plumbing Fixture Requirements

Associations between AQUATIC VENUES and disease outbreaks have been well documented in the literature. Though an outbreak has never been connected to the materials used specifically, wood and other porous materials have been shown to have bacterial growth on them that can be hard to remove. Non-porous materials used as matting at AQUATIC FACILITIES were found to be contaminated with bacteria and biofilm scum layers, although conventional cleaning was documented to remove the contamination[307]. Biofilms are a complex collection of microbes that attach to a wet surface and form a scum layer that harbors bacteria and other microbes that could cause illness. Once established, biofilms provide a home for a variety of microbes such as *Pseudomonas* and are hard to remove. Biofilm-associated bacteria are much more resistant to HOCl compared with free swimming microbes. Design options to reduce biofilm formation as well as sanitizing systems with effective validation, could be useful for reducing biofilm formation.

5.10.5 Provision of Suits, Towels, and Shared Equipment

5.10.5.1 Towels

The drying temperature is more important than the wash temperature when destroying potential infectious pathogens.

- See CDC recommendations for laundering entitled "Environmental Cleaning & Disinfecting" for MRSA at: https://www.cdc.gov/infection-control/hcp/environmental-control/laundry-bedding.html.

5.10.5.4 Shared Equipment Cleaned and Sanitized

Research has demonstrated that play features, mat materials, and other shared equipment found at AQUATIC FACILITIES and water parks can harbor bacteria, even while submerged in chlorinated water. Damp materials that were not submerged in water contained the highest populations of bacteria. Damp play features designed for infants and toddlers were found to be likely vehicles for transference of gastrointestinal bacteria[308]. Sanitization is defined as reducing the number of microbes that are considered safe by public health STANDARDS. This might be achieved through a variety of chemical or physical means including chemical treatment, cleaning, or drying. Associations between swimming POOLS and disease outbreaks have been well-documented in the literature. Though an outbreak has never been connected to play features or the type of play feature material specifically, the possibility could exist due to biofilms found on these materials. Outbreaks may be more likely if the AQUATIC FACILITY is not maintained properly. Biofilms are structured communities of microorganisms encapsulated within a self-developed polymeric matrix that adhere to a living or inert surface. In AQUATIC VENUES, biofilms form readily in water distribution and recirculation lines, filters, collector tanks, and swimming POOLS. Biofilms form when bacteria begin to excrete a slimy, sticky substance that allows them to adhere to surfaces. The biofilm mass usually consists of many species of bacteria, and can also include fungi, algae, and protozoa. Biofilms are resistant to CHLORINE and are difficult to remove once initial adhesion occurs. The biofilm slime shelters disease-causing microorganisms, protecting them from CHLORINE DISINFECTION. In addition, biofilms exert an oxidant demand, consuming CHLORINE residuals in the distribution line and requiring higher doses at the treatment station for residual maintenance at the end of the line. Design options to reduce biofilm formation as well as sanitizing systems with effective validation, could be useful for reducing biofilm formation.

Contact

Shared equipment that comes in contact with mucous, saliva, eyes, or ears require sanitizing to prevent transmission of potential disease-causing pathogens.

5.10.5.5 Other Equipment

Shared equipment which is handheld or used as a flotation device used in aquatic therapy or play have also been found to harbor potential harmful microorganisms, even while submerged in properly chlorinated water. Bacteria found in these environments are most likely from biofilms that have attached to these surfaces. Soaking in DISINFECTANTS might not be enough to penetrate the biofilm; to control biofilm growth, it is recommended to physically remove the slimly film by scrubbing equipment on a routine basis. The array of organisms isolated from damp features suggests that features need to be cleaned, SANITIZED, and thoroughly dried on a routine basis using a combination of chemical and physical methods, preferably as recommended by the manufacturer.[116]

5.11 Water Supply/ Wastewater Disposal

5.12 Special Requirements for Specific Venues

5.12.1 Spas

5.12.1.2 Drainage and Replacement

For example, a 600-gallon SPA divided by 3 yields 200 divided by 25 *(the average users per day)* produces an 8-day water replacement interval.

5.12.2 Waterslides and Landing Pools

Weight is a key variable in the operation of WATERSLIDES. ASTM 2376 contains STANDARDS for manufacturer and operator responsibilities regarding WATERSLIDE systems. Manufacturer's responsibilities include specifying the maximum number of riders that are to ride in the FLUME at one time and rider weight requirements. Owner/operator responsibilities include specific WATERSLIDE operation policies and procedures including signage addressing maximum/minimum height and weight. See further Annex discussion at MAHC 6.4.2.2.3 on sign messages.

5.12.3 Wave Pools

5.12.3.1 Life Jackets

The intent is to make lifejackets readily available at the AQUATIC FACILITY/venue to ensure PATRONS have easy access and use of such drowning prevention devices. This should mean that PATRONS are not discouraged from using them due to cost, visibility, or having to request them. Management should plan for the simplest solution to ensure all PATRONS have access. Consideration should be given to how many life jackets should be available on hand and a mechanism for accomplishing proper sizing.

5.12.4 Therapy Pools

5.12.5 Lazy Rivers

5.12.6 Moveable Floors

5.12.7 Bulkheads

5.12.8 Interactive Water Aquatic Venues

5.12.9 Wading Pools

5.12.10 Other Aquatics Venues

6.0 Aquatic Facility Policies and Management

6.0.1 Staff Training

POOL chemical injuries are a common occurrence as discussed in MAHC Annex 4.9.2. These injuries have been caused by eye splashes, skin exposures, and inhalation following improper handling or lack of use of PPE. Some incidents have involved the release of gases affecting multiple BATHERS or staff. There is a need to reinforce appropriate POOL chemical handling and STORAGE. This applies to both longer-term staff but also seasonal employees and young workers who might be less likely to receive appropriate training. Discussion of PPE, hazard communication, and bloodborne pathogens provisions are required since they are part of OSHA regulation. Most employers, including swimming POOL programs, are required to comply with OSHA regulations and ensure training is adequate.

6.0.1.6.1 Training Topics

Special attention should be given to recognition of symptoms of acute exposure to CHLORINE gas per the Safety Data Sheet *(SDS) (cough, throat irritation, choking, eye irritation with watering, pain, or redness, shortness of breath, skin irritation, vomiting, delirium)*, ozone if used at facility as a SECONDARY TREATMENT *(throat irritation, nasal dryness or irritation, shortness of breath, cough, eye irritation, nausea, headache, drowsiness, chest pain)*, or any other chemicals used for DISINFECTION.

6.0.1.8 Body Fluid Exposure

CDC's Healthy Swimming Site contains additional information on Recreational Water Illnesses *(RWI)*. Employees should not swallow the AQUATIC VENUE water and should thoroughly wash their hands after responding to fecal contamination of AQUATIC VENUE water or body fluid contamination of surfaces.

- CDC's Healthy Swimming Site:
  - https://www.cdc.gov/healthy-swimming/
- See OSHA 1910.1030 Bloodborne Pathogens:
  - https://www.osha.gov/bloodborne-pathogens/standards
- CDC's guidance on Cleaning Up Body Fluid Spills on Pool Surfaces:
  - https://www.cdc.gov/healthy-swimming/response/responding-to-blood-and-vomit-in-the-pool.html

6.1 Qualified Operator Training

6.1.1 Qualified Operator Qualifications and Certification

AQUATIC VENUE operation and maintenance violations are common. POOL inspection data from 16 jurisdictions across the United States indicate that over three quarters *(78.9%)* of inspections identified one or more violation*(s)* and 11.8% of routine POOL inspections resulted in immediate closure because of the seriousness of identified violation*(s)*. In addition, violations regarding the following issues were frequently identified:

- DISINFECTANT concentration *(9.2% of POOL inspections)*,
- pH *(12.4%)*,
- Automated chemical feeder approved, in good repair, or operating *(6.2%),*
- ENCLOSURE *(5.7%)*,
- SAFETY equipment *(16.6%)*, and
- POOL chemical labeled, stored safely, and secured *(18.1%)*[1]

Review of SPA inspection reports from these same jurisdictions found 15.1% of inspections resulted in immediate closure because of the seriousness of identified violation*(s)*. In addition, SPA inspection data indicated that the following violations regarding the following issues are frequently identified:

- DISINFECTANT concentration *(19.2% of inspections)*,
- pH *(27.5%)*,

- Automated chemical feeder approved, in good repair, or operating *(4.5%)*,
- POOL chemical labeled, stored safely, and secured *(9.9%)*, and
- SPA water temperature *(7.5%)* [1]

The authors conclude that the number of overall violations highlights the need for POOL and SPA staff training, which includes information about pathogen transmission, and the potential benefits of mandating training for POOL operators throughout the United States. In addition, it underscores the need for operator training courses to include the topic areas related to the common violations listed above. The pathogens causing approximately 13.7% of reported RWI outbreaks of acute gastrointestinal illness associated with treated recreational water are CHLORINE sensitive[119]. This CHLORINE sensitivity of pathogens involved in outbreaks indicates that these AQUATIC VENUES were poorly operated or managed and calls for requiring operator training[310, 311]. During 2015–2017, POOL chemical injuries led to an estimated 13,508 total ED visits *(95% CI = 9,087–17,929; rate = 1.4 per 100,000 population)*. An estimated 5,245 patients *(95% CI = 3,135–7,355; rate 0.5 per 100,000 population)* had their injury diagnosed as poisoning, predominantly caused by inhalation of fumes or dust *(e.g., when opening containers)*. An estimated 3,745 injuries *(95% CI = 2,497–4,994)* were diagnosed as dermatitis or conjunctivitis, and an estimated 2,588 *(95% CI = 644–4,533])* were diagnosed as chemical burn when POOL chemicals were not secured away from children, or when POOL chemicals were added to the water just before the patient entered the water. The authors conclude that preventing these events calls for educating public POOL operators and residential POOL owners about safe chemical handling and STORAGE practices.[203]

Operator Training Reduces Pool Inspection Violations

Studies have shown that POOLS with operators who have successfully completed formal training in POOL operation, have better water quality than POOLS without a trained operator. Results from a study in Nebraska demonstrated that free CHLORINE violations and concurrent pH and free CHLORINE violations were twice as likely in local jurisdictions not requiring certification compared with jurisdictions requiring training. The authors conclude that these results demonstrate the benefit of requiring POOL operator certification to help prevent RWIs.[310, 311]

6.1.2 Essential Topics in Qualified Operator Training Courses

See section 6.1.1 for discussion.

6.1.2.1 Course Content

6.1.2.1.1 Water Disinfection

Many other DISINFECTION chemicals or systems with varying effectiveness and suitability are being offered in the market to AQUATIC FACILITY operators for water treatment. In general terms, discuss the evaluation steps that should be used by the AQUATIC FACILITY operator, including required AHJ acceptance of the chemicals or systems for public AQUATIC FACILITIES, in their decision process on using these types of supplemental systems or treatments.

- *DISINFECTANTS* – Training should address OSHA "Right-to-Know" and Hazard Communication STANDARDS and other SAFETY aspects.
- *CHLORINE* – Special emphasis should be given to safe STORAGE and handling. See MAHC Annex 4.9.2 for discussion on POOL chemical injuries.
- *Combined CHLORINE* – A discussion of deterioration of buildings, machinery, and structures due to the effects of airborne chloramines in INDOOR AQUATIC FACILITIES is appropriate.
- *SECONDARY TREATMENT* – It is appropriate to include a discussion of the effectiveness of in-line treatment versus side stream treatment.
- *SUPPLEMENTAL TREATMENT SYSTEMS* – It is appropriate to include a discussion of the effectiveness of in-line treatment versus side stream treatment.
- *Water Balance* – Water balance elements should include options for treatment including priority of factors to be adjusted.
- *Water Clarity* – Discussions should include treatment priorities to improve clarity.
- *pH* – It is also important to remember that there are limits on Phenol Red readings when very low or very high pH readings occur.

- *Mechanical Systems* – Common current alternative filter media types that can be mentioned include perlite, zeolite, and crushed glass.
- *Circulation Pump & Motor* – The operator should also become familiar with submerged pumps such as turbine, mixed flow, and others used in waterpark applications. Additionally, the operator needs to understand the winterizing needs for these types of equipment.
- *Filter Backwashing/Cleaning* – In these days of energy and water conservation, it is increasingly important that water conservation be practiced. Backwash water can be responsible for wasting an unnecessary amount of water if not done properly or too frequently.

If properly treated to meet water quality STANDARDS, AQUATIC FACILITIES can obtain savings with water costs. However, in some cases, it might not be cost effective for an AQUATIC FACILITY to expend funds on retreatment of backwash water. In those cases, it is most important that all water is discharged properly in accordance with the regulations of the local jurisdiction.

6.1.2.1.4 Health and Safety

6.1.2.1.4.1 Recreational Water Illness

The number of outbreaks associated with recreational water has continued to substantially increase since reporting began in 1978, most notably in 2007 and 2016. CDC recommends that public health and the aquatic sector collaborate on educating the swimming public, an important source of recreational water contamination, about RWIs and what swimmers can do to protect themselves and others.(33)

6.1.2.1.4.3 RWI Prevention

The operator should be aware of the need for frequent manual testing, STANDARDIZATION of automatic controllers, and adequately sized chemical feeders. Note the need for larger feeders for waterpark type attractions as compared with FLAT WATER POOLS.

6.1.2.1.4.6 Chemical Safety

It is important that the operator be able to read chemical labels and SDS. These include but are not limited to, NFPA 400 "Oxidizer Hazard Classifications and Storage" recommendations. Reporting of POOL chemical injuries in the United States is not universally mandated, and no single surveillance system exists to characterize completely the number of exposures or associated injuries. However, one study of POOL chemical-associated events showed 71.9% of the events involved human error(206). NEISS and the NPDS data indicate that POOL chemical exposures and associated injuries are common. Data from NEISS show that poisoning *(predominantly from inhalation of chemical fumes)* and conjunctivitis or dermatitis *(from splashing POOL chemicals into the eyes or onto the skin)* were the leading POOL chemical injuries for which patients sought emergency treatment. NPDS data reveal that nearly all single POOL chemical exposures likely were unintentional. Additionally, poor chemical handling and STORAGE practices at public AQUATIC FACILITIES, particularly those leading to mixing of incompatible chemicals, were the primary contributing factors of POOL chemical injuries reported in New York State. Although no one data source alone clarifies completely the epidemiology of POOL chemical injuries, together they reveal multiple commonalities that suggest these injuries are preventable. The foundations of CDC recommendations(208) for preventing injuries associated with POOL chemicals were based on a review of the New York State data and other government regulatory guidance. These recommendations focus on improving engineering *(e.g., facility design)*, education *(e.g., training that stresses safe chemical handling and STORAGE practices and safe and preventive maintenance of equipment)*, and enforcement(203).

6.1.2.1.4.7 Entrapment Prevention

The CPSC reports injuries and fatalities regarding entrapment in residential and commercial AQUATIC VENUES.(312)

6.1.2.1.5 Operations

Types of AQUATIC FACILITIES that are recommended to be discussed include POOLS, interactive water AQUATIC VENUES, LAZY RIVERS, THERAPY POOLS, SPAS, WAVE POOLS, WATERSLIDES, competition POOLS, and WADING POOLS. Settings of AQUATIC FACILITIES that are recommended to be discussed include

community POOLS, apartment complex/condominium/homeowners' association POOLS, hotel/motel POOLS, and water parks.

6.1.2.1.5.4 Daily/Routine Operations

SVRS Systems: See MAHC Annex 4.7.1.6 for discussion of SVRS systems.

6.1.3 General Requirements for Operator Training Courses

6.1.3.3 Course Length

The MAHC intentionally does not prescribe a particular length of time for courses. Instead, the MAHC is more performance-based by requiring that all the essential topics in MAHC 6.1.2.1 be covered during the course. Most nationally recognized operator training courses run approximately 16 hours, and the MAHC assesses that it would be unlikely that all essential topics could be effectively taught in a shorter time period.

6.1.3.4 Instructor Requirements

Recognized training on AQUATIC FACILITY operation and maintenance as well as instruction *(without work experience)* is sufficient to qualify an individual to be an instructor if the requirements in MAHC Code 6.1.3.4 are met. It is, however, ideal to have both work experience and training in operation and instruction.

6.1.3.5 Final Exam

The final exam is intended to assess the knowledge and skills of the POOL operator. Key components of the exam should include questions on the essential topics outlined in MAHC 6.1.2, performing essential calculations, reading meters and electronic equipment. In the future, it would be ideal if course final exams included more than just knowledge testing and have skills testing. This should include an onsite evaluation of skills such as proper calculations of quantity and chemicals needed to be added to the AQUATIC VENUE, how to operate the filtration/RECIRCULATION SYSTEM, including backwashing the filters, and water testing *(chemical and physical parameters)*. The Conference for Food Protection established Food Protection Managers Certification Program Standards[313]. The MAHC has established the CMAHC (www.cmahc.org), which in turn might establish POOL operator certification program STANDARDS at a future date. These STANDARDS will address issues such as examination development, test administration, and computer-based testing development and administration.

6.1.3.6 Course Certificates

The MAHC recommends that each certificate have a unique identifier to minimize the likelihood of mistaking the identity of QUALIFIED OPERATORS.

At this time, a certification process for QUALIFIED OPERATORS is not established. This might make it advisable for some group to develop a certification program similar to that of the Food Code. Thus, the Food Protection Managers Certification Program Standards, Section 7.7, "Responsibilities to the Public and to Employers of Certified Personnel" reflect the following, "A certification organization shall maintain a registry of individuals certified." These STANDARDS reference certified food operators; however, the same STANDARD shall apply to operator training certificates. Thus, "any title or credential awarded by the course approved organization shall appropriately reflect the" AQUATIC FACILITY QUALIFIED OPERATOR responsibilities and "shall not be confusing to employers, consumers, related professions, or interested parties."[313]

6.1.3.7 Continuing Education

It is recommended that a QUALIFIED OPERATOR continue their education by attending seminars or training courses to keep up to date in AQUATIC FACILITY operation and SAFETY. In the long term, there is a need for development of a system for CEUs..

6.1.3.8 Certificate Renewal

Nationally recognized operator training courses require renewal of certificates. However, most professional certifications do not require retaking an entire course to renew certification, just passing an exam. Most states require these certificates or copies to be readily accessible to the AHJ. Copies of certificates should be kept on file at the site and made available upon request. If photocopies are provided as proof of certificate, or certificate renewal, the original documents should be provided within 72 hours upon request from the AHJ.

6.1.3.9 Certificate Suspension and Revocation

The AHJ is expected to contact course providers with questions about the validity of any certificate or with questions about an operator's performance. In turn, course providers are expected to readily provide verification of certificates and suspensions and revocations of certificates and to notify the AHJ of actions taken in response to its reported concerns. The Food Protection Managers Certification Program Standards, Section 7.5 reflect the following, "A certification organization shall have formal certification policies and operating procedures including the sanction or revocation of the certificate. These procedures shall incorporate due process."[313]

6.1.3.10 Additional Training or Testing

Reasons for requiring such training or testing include but are not limited to operator performance or new developments in technology or operation. Such situations include but are not limited to repeat or serious violations identified on inspection, an investigation implicating operation as a contributing factor to illness or injury, or implementation of substantial rule changes. Training can range from brief dialogue during POOL inspection to full-day seminar for all operators in a jurisdiction. Testing can range from questions during inspection to paper- or computer-based exams.

6.1.3.11 Certificate Recognition

The MAHC aims to delegate authority to the AHJ both to choose to recognize individual certificates and to reverse its decisions if operators with certificates demonstrate inadequate knowledge or poor performance or due cause.

6.1.3.12 Course Recognition

The MAHC aims to delegate authority to the AHJ to choose to recognize operator training courses and to reverse its decisions if operators demonstrate inadequate knowledge or poor performance or due cause.

6.1.3.13 Length of Certificate Validity

A number of operator training course providers, including the Aquatic Training Institute, Pool and Hot Tub Alliance, and National Recreation and Park Association have set the maximum length of operator certificate validity and certificate renewal at 5 years.

6.2 Lifeguard Training

This portion of the MAHC deals directly with providing QUALIFIED LIFEGUARDS in an AQUATIC FACILITY to first, reduce the risk that could lead to injury and, secondly, appropriately respond to incidents when they happen. The duties of an AQUATIC FACILITY lifeguard have been compared with a number of other occupations including comparing the role of the police officer to that of a lifeguard at a swimming POOL.[314] "The majority of the time, the task is very sedentary, sitting and watching. A quadriplegic could do it; until someone needs rescuing. Then the quadriplegic could not perform the required functions. It does not often happen to a lifeguard that someone needs rescuing, perhaps 0.1% of the time. But the ability to jump into the water and save the drowning victim is critical to the job. This is the reason why there has been someone sitting and watching for the other 99.9% of the time." Bonneau and Brown's position[315] is that, because the disabled lifeguard is unable to perform the critical and essential part of the job, he is incapable of doing the job of lifeguard. Even if he can do 99.9% of the job, he should not be employed as a lifeguard. The perception of the public is that all lifeguards can perform all that is critical and essential to their job set. Unfortunately, this has sometimes been proven to be false. Many drowning deaths resulted from omissions of basic SAFETY precautions.[316-323] These include absent or inadequate POOL fencing, unattended young children at AQUATIC VENUES, faulty POOL design resulting in victims becoming trapped below the surface of the water, poor POOL maintenance resulting in murky or cloudy water that obscured sight of submerged bodies, lifeguards being distracted by socializing with others and doing other chores such as manning admission booths and doing housekeeping chores while on lifeguard duty, and poorly trained lifeguards who did not recognize a person in trouble in the water or had not been properly trained in rescue and resuscitation techniques. In some cases, these are correctable issues that could prevent drowning deaths. We anticipate that if POOL and water SAFETY STANDARDS are strictly enforced, and as lifeguards continue to become better trained and adhere to important basic principles of surveillance, rescue, and resuscitation, the death rate in

public AQUATIC FACILITIES should decline. The goal of this section is to give POOL owners and operators BEST PRACTICE guidelines for guarded and unguarded POOLS as tools to make AQUATIC FACILITIES safer for the general public.

6.2.1 Lifeguard Qualifications

Every day, about ten people die from unintentional drowning[324]. Of these, one is a child ages 1–4 years. Drowning is the fifth leading cause of unintentional injury death for people of all ages, and the second leading cause of unintentional injury death for children ages 1–14 years.[324] From 2010-2019, there were on average 3,619 fatal unintentional drownings *(non-boating related)* in the United States per year and more than one in six people who die from drowning are children ages 0–14 years[324]. Nonfatal drowning can cause brain damage that can result in long-term disabilities including memory problems, learning disabilities, and permanent loss of basic functioning *(e.g., permanent vegetative state)*.[325, 326] Appropriately trained lifeguards are one way to reduce this risk at public AQUATIC VENUES.

6.2.1.1 Course Content

This section defines a broad scope of lifeguard training which is further described in the section below. These topics are universally found in all currently recognized national lifeguard training programs.

6.2.1.1.1 Hazard Identification and Injury Prevention

Lifeguards have an obligation to know and understand common hazards associated with AQUATIC VENUES, and how they can be mitigated or prevented. A vital component of this obligation is to provide PATRON surveillance, commonly referred to as scanning. To prevent injuries, a lifeguard must be taught how to recognize various swimmer conditions that need intervention such as “active,” “passive,” and “distressed,” and to use scanning strategies and techniques to be able to see and identify the emergency. This instruction is incomplete without also teaching lifeguards how to identify factors and circumstances which can impede victim recognition, such as overcrowding, cloudiness of the water, glare, or obstacles on the DECK or in the water such as SLIDES, inner tubes, or structures.

6.2.1.1.2 Emergency Response Skill Set

Lifeguards should have a clear understanding of the responsibilities and actions of not only the physical skills, but also the cognitive and decision-making skills involved in an emergency response. Training agencies should develop appropriate skills to address the variety of water depths in which a victim can be found. These skills should be trained not only for the technical aspects of the skill, but also how the skill is incorporated into a venue’s EAP. Lifeguards should be trained to respond within the scope of, at a minimum, Basic First Aid skills to provide care for illness or injury that can occur on land within the AQUATIC FACILITY until EMS arrives.

6.2.1.1.3 Resuscitation Skills

Lifeguards should be competent in CPR/AED at the professional rescuer level. The predominant body for the research of such skills is the ILCOR. ILCOR currently reviews available research every 5 years and is composed of physicians and medical researchers from across the globe. One organization from each country/region of the world is assigned to interpret the science-based evidence and prepare guidelines for voluntary use by training agencies in that country/region. In the United States, this designated agency is the American Heart Association *(AHA)*. The AHA collaborates with host groups, training agencies, as well as leaders in the field from nonprofit, educational, and commercial organizations to create the “Guidelines for CPR and ECC.”[327] These recommendations are also commonly known as “AHA Guidelines.” Cardiac Arrest Survival Summit *(formerly known as ECC Update)* conferences are held biennially and feature current CPR research and promote BEST PRACTICES and innovative and effective CPR and AED education methods. Detailed Information about the process and current research is available on the ILCOR (www.ilcor.org/) and the Citizen CPR Foundation (https://citizencpr.org/) websites. Training in and deployment of emergency oxygen for drowning emergencies is considered a best practice by the CMAHC Lifeguarding & Bather Supervision Ad Hoc Committee, supported by an ILCOR review of prehospital administration of oxygen in drowning process resuscitation. For details, see the American Red Cross 2022 Focused Updates and

Guidelines for Healthcare. https://www.redcross.org/content/dam/redcross/training-services/sac/docs/American%20Red%20Cross%20Focused%20Updates%20and%20Guidelines%202022.pdf

6.2.1.1.5 Legal Issues

Lifeguards are part of the pre-hospital chain of response and should have basic understanding of critical legal concepts such as consent, refusal of care, and negligence. Legal topics to be covered are not limited to these listed topics. Training agencies are strongly recommended to add topics based on the typical environment in which the trained lifeguard will be employed.

6.2.1.2 Lifeguard Training Delivery

6.2.1.2.1 Standardized and Comprehensive

A STANDARDIZED method of training with comprehensive materials is essential to the implementation of a consistently delivered lifeguard training program. A specific method is not being recommended by the MAHC.

6.2.1.2.2 Skills Practice

While much of the necessary cognitive knowledge can be obtained through self-directed study, especially in an interactive online format, physical skills practice is necessary to develop an understanding of how to apply knowledge and identify the various needs in an emergency. During skills practice an instructor can provide individualized learning approaches, corrective feedback, and lead simulations and scenarios.

6.2.1.2.3 Shallow Water Training

It is important that the student lifeguard be able to practice and be tested in the deepest water specified in their certification.

6.2.1.2.4 Deep Water Training

It is important that the student lifeguard be able to practice and be tested in at least the minimum water depth specified in their certification.

6.2.1.2.5 Sufficient Time

This CODE does not prescribe a particular length of time for courses. Instead, this CODE is more performance based by requiring that all the essential topics in MAHC 6.2.1.2 are covered by the training agency. National lifeguard training courses *(not renewal courses)* currently range from approximately 20–30 hours based on the type of training received for specific AQUATIC VENUES such as waterfronts or waterparks and the AHJ approval. Numerous factors make a uniform course length difficult to specify. Pre-existing knowledge, student-to-teacher ratio, internet-based learning formats, and course level are examples of these factors.

6.2.1.2.6 Certified Instructors

The instruction of an instructor course by an individual not directly authorized by the training agency as a lifeguard instructor trainer is extremely problematic and risks the quality controls established by the training agency. This also places public SAFETY at risk, in that the unauthorized instructor might not be fully qualified to teach the materials as intended. It also affects the training agency in that there is no direct recourse against an unauthorized, and unqualified, instructor. Lifeguard certifications, obtained from a lifeguard training course taught by an instructor who is not currently certified or authorized by the training agency to teach lifeguarding courses, will not be recognized as certified or trained by the AHJ per MAHC 6.2.1.3.

6.2.1.2.6.1 Minimum Prerequisites

The creation of minimum instructor prerequisites is a crucial piece to create quality and consistency for the training agency.

6.2.1.2.6.2 Completed Training

Although the MAHC requires only completion of a lifeguard and lifeguard instructor training course as a prerequisite, an effective instructor understands the demands, stresses, and practical application of skills that can be gained from actual lifeguarding experience or the benefit of extensive training in an AQUATIC FACILITY environment. Instructors who lack such experiences might not fully understand the requirements and demands

of a lifeguarding position and might not provide an experienced instructor's insight to students on how to apply the skills and knowledge found in the training agency curriculum. It is necessary that lifeguard instructors have a firm understanding of the course they will be teaching. While it might be possible for an individual to pass a lifeguard instructor course without first taking a basic course, such an instructor would lack a firm understanding of the skills required by the training agency. It should be noted however, that training agencies should have the ability to create curriculum that would allow an individual from another training agency, or an individual who chooses to take an alternative to a full basic level course, to become instructors.

A Lifeguard Instructor Training Course must also provide information to the instructor candidates on how to safely and effectively conduct a course including:

- Knowledge of how to provide for the health and SAFETY of the students. *(example knowing how to DISINFECT manikins for use)*
- Ability to maintain adequate supervision at all times during in water skills and have a lifeguard on duty
- Knowledge of how to effectively use program materials and training equipment as listed in MAHC 6.2.1.2.7
- Ability to supervise student skill practice and provide timely, positive, and corrective feedback
- Knowledge and ability to evaluate students as to meeting the criteria set forth by the training agency for which they are an instructor

6.2.1.2.6.3 Instructor Renewal/Recertification Process

The training agency must have a process in place for renewal/recertification of instructors. The process should identify the criteria when reauthorization is required such as an instructor must teach a certain number of lifeguard courses in a certain time period *(years)* or do in-person or online updates as needed *(e.g., when course materials or content have been revised)*.

6.2.1.2.6.4 Quality Control

Quality instruction is crucial to the survival of a training agency and, in the case of lifeguard training, crucial to the SAFETY and well-being of millions of swimmers every year. Training agencies must have procedures that allow for the correction, remediation and, if necessary, the revocation of instructor credentials.

6.2.1.2.7 Training Equipment

These pieces of equipment are required to accomplish the objectives of lifeguard training as outlined in the CODE. It is educationally sound to provide enough equipment based on the number of students who will be using it at the same time. Below is a listing of ratios recommended by several agencies; however, the training agency can adjust ratios based on their own delivery method.

American Heart Association

- Adult, child, and infant CPR training manikins *(one manikin per three students per class period)*,
- CPR masks *(one per three students)*,
- Valves for CPR masks *(one per student)*,
- AED trainers *(one per three students)*,
- Bag-valve-mask resuscitators *(one per three students)*, and
- Manikin cleaning supplies *(as needed between students and after class)*

American Safety & Health Institute

- Recommended student to equipment ratio: 3 to 1

American Red Cross

- Rescue tubes (one for every two participants)
- Backboards with at least one strap and head immobilizer device (one for every three participants)
- Adult and Infant CPR manikins (one for every two participants; child manikin optional)

- Adult and Infant Bag-valve-mask (BVM) resuscitators (one for every two participants; child BVM optional)
- AED training devices and pads (one device and set of pads for every two participants)
- Whistles (one for every participant)
- Hip packs (one for every participant)
- Adult and Infant Resuscitation masks (one for every participant)
- Latex-free disposable gloves (multiple sizes)
- Gauze pads
- Roller bandages

6.2.1.3 Competency and Certification

6.2.1.3.2 Requirements

The readiness of lifeguard candidates to respond to aquatic-based emergencies should be assessed thoroughly for skill mastery, knowledge, and practical application prior to being issued a certificate. For the written exam, all nationally recognized training agencies currently require an 80% correct answer rate as the minimum threshold for passing.

6.2.1.3.3 Instructor Physically Present

The physical presence of the instructor of record ensures that students are evaluated accordingly in both cognitive and physical testing. This also substantially reduces the risk of individuals becoming certified who lack the basic skills and knowledge necessary through either acts of omission caused by the substitution of another individual to provide testing, or by student fraud. In addition, the instructor of record should be actively overseeing or conducting the testing to ensure quality control and that all testing objectives have been met.

6.2.1.3.4 Certifications

A certification issued at the end of a lifeguard course indicates that the individual successfully met the training requirements on the day of assessment. A completion certificate does not imply future performance or suitability in all circumstances. It is the responsibility of the employer to verify skills and ongoing competency suitable for the environment in which the lifeguard will be assigned through pre-service and in-service training.

6.2.1.3.5 Number of Years

The USLSC final report[328], the scientific review by the ARC[329], and the MAHC agree that lifeguarding skills need to be refreshed as often as possible. The ARC reviewed 12 peer-reviewed publications on CPR skill retention in healthcare providers *(retraining intervals of 6 weeks–24 months)* and 28 papers focused on non-healthcare providers *(retraining interval of 3–48 months)*.[329] The data from these 40 studies *(all measured manikin skills, none measured patient outcomes)* showed significant CPR skill degradation within the first year after training in both job categories and the majority of skill degradation occurred in the first year. None of the 40 studies documented adequate skill retention after 2 years but several showed improved retention if a brief refresher was given at 6–12 months. As a result of this review and the low probability that lifeguards use the skill often enough in their job to retain the skill, the MAHC felt that the skills needed to be refreshed every year through re-certification. They did not think that the convenience of aligning the length of valid certifications for lifeguarding and first aid at 2 years overrode the strong data showing CPR skill degradation over 2 years that could put BATHER health at risk. The time periods listed in the MAHC are acceptable only if ongoing in-service and pre-service STANDARDS are followed.

6.2.1.3.6 Documentation

To verify compliance with MAHC 6.2.1.3.5, requiring the expiration date of the certification allows employers and the AHJ to identify that the lifeguard has a current certification. Providing the level of training gives guidance for the employer or AHJ for suitability in specific AQUATIC VENUES. Examples of level of training include: Lifeguard, Waterpark Lifeguard, Waterfront Lifeguard, and Shallow Water Lifeguard. Such descriptions are not necessarily universal among all current training agencies. The ability to identify the

lifeguard instructor allows for higher quality control by the training agency. It also aids in the prevention of fraudulent certifications. Clearly stating the restrictions on water depth for which the lifeguard is qualified allows the employer and the AHJ to quickly ascertain the basic abilities of the lifeguard that were assessed during training.

6.2.1.3.7 Expired Certificate

A 45-day grace period after certificate expiration, was added to accommodate the numerous lifeguards attending college. Consider a senior in high school who takes their course in April. Subsequently they are now in college and typically will not return from college until early May. A grace period of up to 45 days after certificate expiration allows renewal by taking a challenge exam as opposed to completing a new training course, however the lifeguard is not permitted to lifeguard until renewal training is successfully completed. Expiration beyond 45 days requires the retaking of the course

6.2.1.3.7.2 Challenge Program

A challenge course is one in which a lifeguard demonstrates the essential skills and knowledge required by the training agency. This demonstration is performed without prior review or instruction at the time of the challenge with the certified instructor present. Prompting or coaching is not performed unless necessary to adequately assess skill level *(e.g., "the victim is not breathing")*.

6.2.1.3.7.3 Certificate Renewal

A renewal course can also be described as a recertification course. Review / Recertification courses are abbreviated courses designed to be used to assess that a currently certified lifeguard has the necessary skills and knowledge to perform essential competencies required of the training agency. Although some skills and information are universal to all lifeguard training agencies, there are differences in physical skills. A lifeguard attempting to recertify through a different agency is not likely to have ample time to master these different physical skills. This should not be confused with "crossover" type courses which are specifically designed to teach a currently certified lifeguard the different skills and information from another training agency.

6.2.1.3.8 Certificate Suspension and Revocation

The AHJ is expected to contact course providers with questions about the validity of any certificate or with questions about a lifeguard's performance. In turn, course providers are expected to readily verify certificates and suspensions and revocations of certificates and to notify the AHJ of actions taken in response to its reported concerns. The Food Protection Managers Certification Program Standards, Section 7.5 reflect the following, "A certification organization shall have formal certification policies and operating procedures including the sanction or revocation of the certificate. These procedures shall incorporate due process."[313]

6.2.2 Lifeguard Supervisor Training

6.2.2.1 Lifeguard Supervisor Candidate Prerequisites

The age of 18 years and above was an adequate age to consider a person as being mature enough for this position but there are many examples of good supervising at a younger age. This was a starting point but many other factors regarding experience, training, management skills, and others were equally or more important. For this reason, the minimum age for a LIFEGUARD SUPERVISOR is not specified and is limited to meeting the minimum age requirement of a lifeguard and having the experience that equates to one season of lifeguarding *(3 months)*. The suggested 100 hours of experience in the role of a lifeguard is subjective but is an effective starting point in determining candidacy as a LIFEGUARD SUPERVISOR. Additionally, this 100 hours of active-duty requirement should be considered recent service. The water rescue skills, knowledge, legal implications, and resuscitation skills have advanced significantly in recent decades so that lifeguarding experiences older than several years may no longer be truly applicable. This concern exists more so with LIFEGUARD SUPERVISOR candidates who have been employed in roles without a direct connection to aquatic safety. The requirement to have successfully completed a lifeguard training course is also key as it ensures the LIFEGUARD SUPERVISOR has the ability, both physically and cognitively, to provide proper support to the QUALIFIED LIFEGUARD team when necessary. The requirement of the ability to communicate in English is related to the ability to effectively activate the EAP and deliver instructions as well as interface with emergency services. This is similar to the requirement on airlines for emergency exit row seating.

6.2.2.2 Lifeguard Supervisor Training Elements

As of the writing of the MAHC, lifeguard supervision and management training courses are limited. In the development of the MAHC, the MAHC recognizes the importance of ongoing AQUATIC VENUE supervision with adequate training in injury prevention and response. What constitutes supervisor and management training was heavily discussed. The concept of "supervisor training" lends itself to far more than simply MONITORING lifeguards and performing essential functions of the lifeguard as needed. Required skills for the supervisor include staff management skills, emergency response, decision making, knowledge of aquatic industry STANDARDS, etc. This list is obviously not comprehensive. This leads to a main concern in the development of a LIFEGUARD SUPERVISOR course which is course content and length. Training agencies are encouraged to develop a system of training LIFEGUARD SUPERVISORS that incorporates the critical components of supervising lifeguards and responding to incidents in an AQUATIC FACILITY as these items directly affect BATHER SAFETY. This might include a variety of levels that address this information in various ways and as appropriate for the intended audience of each level course. The skills and knowledge found in this section are considered by the MAHC to be essential to any LIFEGUARD SUPERVISOR training course, regardless of intended depth of scope. The course outline and requirements mirror that of the lifeguard training course requirements. LIFEGUARD SUPERVISORS need to have knowledge beyond that of the lifeguard training program. The LIFEGUARD SUPERVISOR is responsible for keeping the lifeguard accountable for their own performance and as such should MONITOR scanning and vigilance within the zone of PATRON responsibility. As situations occur, the LIFEGUARD SUPERVISOR will also need to react to reduce risk while they understand the legal responsibilities of the job. Due to the nature of the content in the LIFEGUARD SUPERVISOR training, it is possible for this content to be delivered in person or online utilizing various methods such as video and interactive media to establish competency.

6.2.2.3 Lifeguard Supervisor Training Delivery

6.2.2.3.1 Standardized and Comprehensive

The term STANDARDIZED is meant to convey that the materials are STANDARD, in writing, and are consistent from one course to another when delivered. This would require that providers, whether an agency or an AQUATIC FACILITY, have a STANDARD method to deliver the course.

6.2.2.3.2 Sufficient Time

A course length is not specified as each training agency may have their own program that incorporates all the requirements but may also add other topics. The method used to effectively instruct is up to the training agency. Some may take more time than others. The MAHC is not prescriptive on timing but rather on a course timeline that allows for covering the course content.

6.2.2.3.4 Lifeguard Supervisor Course Instructor Certification

This is the same rationale as for lifeguard training.

This allows for an AQUATIC FACILITY to have its own internal LIFEGUARD SUPERVISOR training course or use a training course through a training agency.

6.2.2.3.4.2 Minimum Prerequisites

This allows for experienced supervisors that may not have the physical skills to do the current lifeguard course as defined by the MAHC but still require the knowledge of lifeguarding. The LIFEGUARD SUPERVISOR instructor training course utilizes the same rationale as the lifeguard Instructor training course in MAHC 6.2.1.2.6.1.

6.2.2.3.4.3 Quality Control

This is the same rationale as for lifeguard training in MAHC 6.2.1.2.6.4.

6.2.2.4 Competency and Certificate of Completion

6.2.2.4.1 Lifeguard Supervisor Proficiency

LIFEGUARD SUPERVISOR testing could be in many forms from situational-based observations, shadowing with an experienced supervisor, or testing technical knowledge. Some LIFEGUARD SUPERVISOR skill proficiencies can be subjective so the methodology for testing is not prescribed in the CODE.

6.2.2.4.2 Lifeguard Supervisor Certificate of Completion

This uses the same rationale as for the lifeguard instructor training course found in MAHC 6.2.1.3.4. It is the intent of the MAHC to require completion of a course meeting the described requirements. At this time, it is not intended to be an ANSI-defined certification process, which will require such items as delivering training instruction independently from the testing and assessment process.

6.3 Facility Staffing

6.3.1 Qualified Operators Requirements and Availability

6.3.1.2.5 Onsite Responsible Supervisor Duties

The RESPONSIBLE SUPERVISOR should know how and when to contact the contracted off-site QUALIFIED OPERATOR. This includes every time that there is a suspected compromise to the recirculation and DISINFECTION system for which the RESPONSIBLE SUPERVISOR does not immediately understand the cause and any mechanical malfunctions or personnel errors that have led to suspected chemical exposure of PATRONS or staff.

6.3.2 Aquatic Facilities Requiring Qualified Lifeguards

6.3.2.1 List of Aquatic Facilities Requiring Qualified Lifeguards

There are many conditions that result in higher risk for BATHERS in an AQUATIC FACILITY or higher risk for any persons attempting to assist a BATHER in distress. These conditions each have their own distinct features that the MAHC felt a QUALIFIED LIFEGUARD presence would reduce those risks. These requirements only apply to AQUATIC VENUES with standing water.

1) ***Deeper than 5 Feet:*** The 50th percentile female adult is at least 63.7 inches *(162 cm)* tall.[202] The rationale is that the average adult BATHER'S head would be above the static water line, and s/he could use the AQUATIC VENUE without difficulty. If a BATHER were in distress, another adult BATHER would be able to assist with equipment or without equipment. Under these conditions, assuming adults are present, the likelihood of providing assistance by untrained persons is high compared with water depths deeper than 5 feet *(1.5 m)*. It is necessary to begin working to prevent some of the deaths caused by greater water depth combined with the lack of lifeguard supervision. The hardship this could cause unguarded AQUATIC FACILITIES is recognized. As a result, the MAHC requirements still allow for existing AQUATIC FACILITIES to be unguarded if they follow the requirements outlined in the MAHC, such as posting required signage. However, new construction of unguarded AQUATIC VENUES will require them to be less than 5 feet *(1.5 m)* deep.
2) ***BATHERS ages 14 years or younger:*** Many STANDARDS recognize that a person who is under the 14 years of age is considered to be a child and that their ability to make decisions, especially when complying with rules, require adult supervision.[330] Because the AQUATIC VENUE presents the risk of drowning at any depth and despite rules being posted, adult supervision is required for compliance with those rules. The 50th percentile female at 14 years of age is 63.4 inches *(161.0 cm)* tall while the 50th percentile female at 13 years of age is less than 62.4 inches *(158.5 cm)* tall.[202] This is a critical time frame in which the 1+ inches *(2.5+ cm)* are the difference between water over one's nose/mouth or the ability to keep the nose/mouth above the static water line.

   The phrase "allows for unsupervised children" implies that an AQUATIC FACILITY that does not allow unsupervised children would not need a QUALIFIED LIFEGUARD. The intent for supervision of children is that parents/guardians or other similar adults responsible for the children are present at AQUATIC VENUE with the children and the children are in sight. The critical component is how this is enforced. In some cases, the facility may have a sign posted that persons under the 14 years of age are not allowed, such as a hotel POOL. In these cases, mechanisms should be in place for MONITORING

and enforcing the rule, understanding that by posting a sign, it is the responsibility of the adult supervising these persons under 14 years of age to also comply with the rule.

3) ***Dedicated Surveillance:*** The responsibilities of a QUALIFIED LIFEGUARD are different from the responsibilities of the chaperone of a youth group. The MONITORING of children in these environments is often more than six children to every chaperone. These responsibilities must be separated by having the presence of a QUALIFIED LIFEGUARD that is not distracted by the activities of the group and is focused on his/her zone of PATRON surveillance. The chaperone, even if trained as a lifeguard, cannot manage both PATRON surveillance and the activities of individual children. If the chaperone is not trained as a lifeguard, it puts them at risk if a rescue is required.
4) ***Group Practice or Instruction***: Competitive swimming, sports, lifeguard training, exercise programs, and group swimming lessons all include multiple persons being instructed by one or more persons for a distinctly different objective. The primary focus is on the activity and not on PATRON surveillance. Like the rationale for youth groups, there is a need to separate the responsibility of the coach/instructor from that of providing dedicated PATRON surveillance. Group swim lessons are an obvious reason to have a QUALIFIED LIFEGUARD as participants are not proficient at swimming, and thus at higher risk for drowning. Lifeguard training, sports, exercise programs, and competitive swimming involve exertion and could result in a BATHER in distress. If the instructor is focused on an individual, the risk of a different person drowning unnoticed is higher than if a QUALIFIED LIFEGUARD was assigned just to PATRON surveillance.
5) ***Large AQUATIC VENUES:*** Aquatic rescue throwing devices have been found to have a reasonable ability to reach 30 feet *(9.1 m)* in distance or less by untrained individuals. AQUATIC VENUES with distances greater than what it is reasonable for SAFETY equipment to be used from the DECK need to be supervised with QUALIFIED LIFEGUARDS.
6) ***Moving Water:*** Anywhere there is moving water, there is a greater chance for a PATRON to be moved by the force of the water in an unwanted manner. This could include moving the PATRON a distance from SAFETY, causing the PATRON to lose their balance and have a sudden submersion, and other disruptive problems. This is not intended to include "normal" flow from filtration system wall INLETS. These AQUATIC VENUES need to have QUALIFIED LIFEGUARD supervision. INTERACTIVE WATER AQUATIC VENUES that do not include standing water are not included in this line item as they have an induced water movement but do not have standing water. There is no QUALIFIED LIFEGUARD requirement for an AQUATIC VENUE with no standing water.
7) ***Waterslide LANDING POOLS:*** WATERSLIDE LANDING POOLS have an induced current from the lift pump providing water as lubrication on the SLIDE. This is not to be confused with POOL SLIDES that are on a POOL DECK and do not have water flowing down them. Some smaller SLIDES have a small amount of water on them to lubricate the surface but generally do not have a dedicated POOL to "catch" or "land" riders and do not generate a substantial current.
8) ***Starting Platforms and Diving Boards:*** The risk of spinal injuries increases with activities involving headfirst entries from starting platforms and diving boards. As such, the need for QUALIFIED LIFEGUARDS to MONITOR behaviors and control the use of starting platforms and diving boards is important.
9) ***Alcohol Use:*** This is frequently reported as a contributing factor in drowning incidents and spinal injuries involving adults in swimming POOLS and similar environments and alcohol consumption by caregivers has also contributed to drowning incidents related to lapses of supervision of children. Where alcohol is sold or served at an AQUATIC VENUE, it introduces additional hazards. A requirement to provide lifeguards where alcohol is sold or served will help to mitigate the risk of serious injury or death introduced by PATRON'S use of alcohol through active surveillance, enforcement of rules, and rescue and emergency care where needed.

6.3.3 Safety Plan

The MAHC agreed that there needs to be a SAFETY PLAN that is specific to the AQUATIC FACILITY. Training agencies, ANSI/APSP-1 and -9 Standards for public swimming POOLS and aquatic recreation facilities all speak to having plans written, rehearsed, and reviewed. That there are other types of plans that detail

processes that directly affect PATRON SAFETY. In the CODE, the SAFETY PLAN is outlined to contain several PATRON- SAFETY components. The SAFETY PLAN is written dependent on whether QUALIFIED LIFEGUARDS are present. *SAFETY PLAN components are different for guarded and unguarded AQUATIC FACILITIES.*

The AQUATIC FACILITY staffing plan is meant to identify positions in the AQUATIC FACILITY that address specific risks as well as support staff that would be present to assist in cases of emergency or provide support by MONITORING performance of QUALIFIED LIFEGUARDS *(for AQUATIC FACILITIES requiring them)*. In unguarded AQUATIC FACILITIES, this plan would include other staff in the staffing plan. Training agencies, ANSI Standards for public swimming POOLS, and AQUATIC FACILITIES all speak to having plans written, rehearsed, and reviewed for emergency action. Pre-employment testing as well as scheduled training is needed to verify that staff members are qualified for the environment. Ongoing in-service training programs for lifeguards, attendants, QUALIFIED OPERATORS, and other aquatic personnel should be required. To address this, the definition for QUALIFIED LIFEGUARD requires ongoing in-service training. Such programs should include drills aimed at raising the awareness of AQUATIC FACILITY surveillance, victim recognition, emergency response, CPR/water drills, and simulations incorporating daily challenges. In addition, in-service training needs to be documented.

6.3.3.1 Code Compliance Staff Plan

In consideration of the requirements of the CODE as it relates to staff, the MAHC recognizes the need for identifying an individual or individuals to be responsible for compliance with the CODE and the general operation of the AQUATIC FACILITY. For this reason, certain functions are identified, and the AQUATIC FACILITY should designate persons to be responsible for each function even if multiple functions are accomplished by a single person. The AQUATIC FACILITY staffing plan is meant to identify risks and create accountability for the prevention or mitigation of such risks by identifying person*(s)* responsible for each.

Risk Management Responsibility

It is important to not only address identified risks but to designate persons who shall be responsible for conducting periodic SAFETY inspections to be proactive about finding and mitigating risk as well as making decisions on closure for imminent hazards. Determining who is responsible for deciding on closure of the AQUATIC FACILITY is important as it empowers the designated person but also creates a clear point-person for staff to go to for making this decision. The AHJ might be conducting periodic reviews and might have recommendations or need additional information. It would be beneficial to identify the individual or position responsible for interfacing with the AHJ to most effectively address changes or to provide background information. This makes it clear to stakeholders where to direct information or requests.

Maintenance and Repair of Risks

Once risks are identified, it is critical to determine who is responsible for mitigating those risks. In some cases, it might be a facility maintenance person responsible for conducting repairs, but ultimately it is the responsibility of management to make sure these risks are addressed. Failure to maintain water and air quality can result in illness and it is the responsibility of the AQUATIC FACILITY to maintain proper air and water quality. In some cases, a maintenance team manages these systems, and in some cases, it may be a third-party contractor or the QUALIFIED LIFEGUARD staff. Nonetheless it is important to determine who is responsible for these systems to minimize the risk to BATHERS.

Enforcing Rules and Responding to Emergencies

It is important to identify who is responsible for rule enforcement. One might assume the QUALIFIED LIFEGUARD is the person responsible for rule enforcement, but by identifying the function here, it will make it clear that their primary role is in preventing injury. QUALIFIED LIFEGUARDS will generally be the first responder to an incident, but other support staff may participate in the EAP, whether QUALIFIED LIFEGUARDs are present or not. Identifying QUALIFIED LIFEGUARDS, LIFEGUARD SUPERVISORS, medical specialists, and management are critical pieces of an EAP and should be identified as a part of the staffing plan in any SAFETY PLAN.

Supervising Staff

It is important to have a person designated as the person responsible for the critical SAFETY functions of an AQUATIC FACILITY. Although each QUALIFIED LIFEGUARD is accountable for their zone, the LIFEGUARD SUPERVISOR makes sure each individual is doing what is expected and is present for responding to emergencies and taking the lead in making decisions about imminent hazards. Accountability for rotations and breaks lies with the LIFEGUARD SUPERVISOR and should be clearly identified in the SAFETY PLAN to show the ability to comply with the CODE.

Training

QUALIFIED LIFEGUARDS who cannot demonstrate proficiency in their lifeguarding skills can be a danger to BATHERS and to themselves. Serious deficiencies that are not immediately corrected can cause the serious injury or death of a BATHER, the QUALIFIED LIFEGUARD, or other staff member. For this reason, it is important to identify who is responsible for conducting pre-service evaluations and in-service training. In both cases, it may be someone specifically trained in evaluating skills or trained in training others.

6.3.3.1.1 Zone of Patron Surveillance

The zones of PATRON surveillance are identified in the SAFETY PLAN so that all stakeholders are aware of the zones, how many QUALIFIED LIFEGUARDS are required to effectively cover all parts of the AQUATIC VENUE(S), and show that each zone can be effectively MONITORED by a QUALIFIED LIFEGUARD in accordance with the CODE. Having identified zones of PATRON surveillance is one of the most needed components for all AQUATIC VENUES. QUALIFIED LIFEGUARDS should be able to determine their area of responsibility and be able to focus on that area. With the proper coverage, all areas of the AQUATIC VENUE needing to be covered would be assigned. One of the challenges in AQUATIC VENUE management is to ensure that QUALIFIED LIFEGUARDS understand the exact scope of their zone of PATRON surveillance. Training agencies and the ANSI Standards for AQUATIC FACILITIES speak to "lifeguards understanding their responsibilities to their assigned stations." This would include understanding what type of position *(e.g., elevated, roaming)* the QUALIFIED LIFEGUARD should be in for the most effective PATRON surveillance. Both the ANSI/APSP-1 and ANSI/APSP-9 Standards state that the lifeguard "shall be positioned and provided equipment to reach the victim within 20 seconds of identification of a trauma or incident *(e.g., response time)*." Note that this time *(20 seconds)* addresses the time the rescuer must reach the furthest extent of the zone, which would include addressing size and shape of each zone, among other factors. It does not include the "recognition phase" in this time. For the purposes of maintaining effective surveillance of a zone of PATRON responsibility, the zone is generally set up based on the location of the QUALIFIED LIFEGUARD and their ability to see the entire zone. In some cases, it requires the QUALIFIED LIFEGUARD roam to see the entire zone. In others, the QUALIFIED LIFEGUARD must be elevated to see the whole zone. For this reason, the SAFETY PLAN must stipulate by what method the QUALIFIED LIFEGUARD can see the whole zone. Additional responsibilities may include MONITORING of adjacent DECKS or MONITORING activities on a structure such as a WATERSLIDE, play element, or other AQUATIC FEATURE. As the aquatics sector has added other AQUATIC FEATURES to traditional AQUATIC VENUES, it is important to identify these additional responsibilities that might not be apparent if the zone were strictly a flat-water POOL. An AQUATIC FACILITY may have more than one AQUATIC VENUE; each AQUATIC VENUE may have multiple zones of PATRON responsibility. These zones may overlap in some areas. It is important to show there are no unassigned areas. The MAHC does not speak to a time STANDARD for identification of an incident versus the response time, as there are too many variables in the circumstances leading to an incident.

6.3.3.1.2 Rotation Procedures

Studies have documented the effect of critical and non-critical signals on maintaining vigilance in tasks; these may be useful in understanding lifeguarding duties. Jerison and Pickett demonstrated that a high number of critical signals could be processed by the lifeguard for up to 60 minutes with tolerable effects on vigilance.[331] However, the study found that low numbers of critical signals indicated that detrimental effects on vigilance occurred after only 20 minutes. This study also referenced the Mackworth Clock Test, commissioned in 1950 by the British Royal Navy, which found that optimal vigilance cannot be maintained for more than 30 minutes.[332] Researcher N.H. Mackworth developed the visual sensitivity loss model. Using classic clock-task experiments, signal detection performance often declined during the first half hour of the watch. Later experiments found five- to 10-minute breaks reset the vigilance level to its original

point.[333] The SAFETY PLAN should specify how breaks or changes in duties will be instituted into the rotation plan without reducing the number of QUALIFIED LIFEGUARDS on PATRON surveillance. For single QUALIFIED LIFEGUARD AQUATIC FACILITIES, the plan needs to address procedures for keeping PATRONS out of the water while the QUALIFIED LIFEGUARD is on break or performing other alternation of task activities. Other AQUATIC FACILITY staff might need to be at poolside to ensure that PATRONS stay out of the water, unless all PATRONS leave the AQUATIC VENUE, and it is appropriately secured against entry. The "off-duty" QUALIFIED LIFEGUARD cannot be responsible for this activity as it does not meet the intent, which is to accomplish a reset of the vigilance level. Having a sound lifeguard rotation plan and procedures is crucial to the ability of the QUALIFIED LIFEGUARDS to be effective in PATRON surveillance. During the rotation of QUALIFIED LIFEGUARDS there can potentially be a lapse of PATRON surveillance if not done correctly. Because of this, the rotation system must be practiced and evaluated as to eliminate or minimize the lapse of PATRON surveillance time. Heat, humidity, and high BATHER COUNTS are stresses for QUALIFIED LIFEGUARDS, which may warrant more frequent breaks. DECK areas are part of the zone of PATRON surveillance for some lifeguard stations to prevent incidents from occurring *(e.g., stop running on DECK, stop diving from DECK to shallow water, and otherwise enforcing rules).*

6.3.3.2 Emergency Action Plan

There needs to be an emergency closure policy that is retained and available for review by the AHJ. Training agencies educate lifeguards to expect a written EAP created by the AQUATIC FACILITY where they will work that addresses the reasonably foreseeable emergencies that could occur. There is a need to identify how emergencies are communicated within the AQUATIC FACILITY and external to the AQUATIC FACILITY. The types of emergencies that could occur in AQUATIC FACILITIES include but are not limited to: chemical spills, submersion events/drowning, fire, violent acts, lost children, contamination *(fecal incidents and water clarity)*, and inclement weather. AQUATIC FACILITY staff will likely be the persons to observe any imminent hazards and should be empowered to close AQUATIC VENUES or other areas of the AQUATIC FACILITY should those hazards be present. In particular, fecal incidents, water clarity, and inclement weather might be encountered more often, and the AQUATIC FACILITY staff should know procedures for dealing with those imminent hazards and their authority to close the AQUATIC VENUE or AQUATIC FACILITY.

6.3.3.2.1 Coordination of Response

The EAP identifies the individuals available and expected to respond. The goal of an EAP for a life-threatening emergency should be to activate EMS and provide for other individuals to assist the QUALIFIED LIFEGUARD with the actions identified in the EAP *(such as CPR, if needed)* as soon as possible. Performing effective compressions is difficult to maintain for more than a few minutes, and the presence of at least one person to take over compressions creates a cycle of rest. In AQUATIC FACILITIES where there are multiple QUALIFIED LIFEGUARDS or other staff persons such as desk or maintenance personnel who are always closely available when the AQUATIC FACILITY is open, it is feasible for many persons who are trained in CPR/AED and first aid to respond within 3 minutes. Having a person who is CPR trained who can respond within minutes greatly improves survivability.[334] At an AQUATIC FACILITY with a single QUALIFIED LIFEGUARD, the SAFETY PLAN should identify the options for obtaining assistance, which is likely to include use of bystanders. If bystanders are part of the EAP, pre-service and in-service training should include how to direct bystanders in an emergency.

6.3.3.3 Pre-Service Requirements

6.3.3.3.1 Safety Team EAP Training

There needs to be a SAFETY PLAN specific to each AQUATIC VENUE. Training agencies, ANSI Standards for public swimming POOLS, and AQUATIC FACILITIES all speak to having plans written, rehearsed, and reviewed for emergency action. It is imperative that EAP training take place before the staff begins their work as an emergency can happen at any time. Providing a copy or posting a copy for staff ensures staff has access to the information at any time.

6.3.3.3.2 Safety Team Skills Proficiency

Responding to emergencies can require more specific skills and physical abilities, which once learned, must be maintained as emergencies can occur at any time. This demonstration of skill or knowledge verifies the staff person is ready to fulfill their role.

6.3.3.3.3 Qualified Lifeguard Emergency Action Plan Training

The QUALIFIED OPERATOR is required to prepare the SAFETY PLAN as a set of policies for the AQUATIC FACILITY. It is imperative that the employees be aware of their responsibilities and have access to the information at all times the AQUATIC FACILITY is open, so they can refresh their memory or seek further information. Training during pre-service will allow the QUALIFIED LIFEGUARD to become trained in the SAFETY PLAN of the AQUATIC FACILITY.

6.3.3.3.4 Qualified Lifeguard Skills Proficiency

It is imperative that all lifeguards hired are currently able to perform effectively in the workplace. AQUATIC FACILITIES need to assess the lifeguard's ability to perform the job skills necessary to be a QUALIFIED LIFEGUARD at the AQUATIC FACILITY, including at any AQUATIC VENUES within the AQUATIC FACILITY where the lifeguard can be assigned, before allowing the lifeguard to be on duty. When first hired, lifeguarding skills should be assessed during pre-service training prior to the first duty assignment. In-service training should assess skills on a regular basis to determine ability for ongoing duty assignments. Training agencies require that employees have training, knowledge, and the proper equipment to protect the employee and the PATRON against pathogen transmission. This level of awareness must be in place before active PATRON surveillance takes place. All lifeguard training agencies require lifeguards to be able to perform a combined rescue skill with equipment to receive completion certification. All lifeguard training agencies train their lifeguards that they must be able and ready to recognize, respond, rescue, and resuscitate a victim as quickly as possible. The employer should verify that the lifeguard maintains these skills in the workplace.

6.3.3.3.6 Documentation of Pre-Service Training

Documentation provides a method for the AHJ to verify compliance. An example of the type of documentation required is a skills check-off form with a participant attendance sheet.

6.3.3.4 In-Service Training

6.3.3.4.1 Documentation of In-Service Training

All lifeguard training agencies support the need for ongoing in-service training. Both ANSI/APSP -1 and -9 state that certain topics be covered in this training. These in-service trainings should include all the SAFETY PLANS and in and out of water rescue skills for lifeguards. The USLSC final report[328] , the scientific review by the ARC[329] and the MAHC, agree that lifeguarding skills need to be refreshed as often as possible. The Texas Administrative Code requires at least 4 hours of in-service a month. Other states require that in-service training be documented and signed. All AQUATIC FACILITIES should have an ongoing in-service program for their SAFETY TEAM members. "Periodic" offers flexibility to the QUALIFIED OPERATOR based on their seasonality, staff scheduling, and the training agency requirements. Much of in-service training is focused on skill building and maintenance as well as competency demonstration and testing so those aspects should be delivered by qualified personnel *(e.g., lifeguard instructors)*. However, in addition to the required in-service training in the MAHC, instruction from individuals that might not be lifeguard instructors but have particular skill sets, training, or unique qualifications that would enhance a lifeguard's skills over and above the in-service training requirements of the MAHC can be provided. For instance, ancillary qualified persons such as EMS personnel, health inspectors, police officers, certified counselors, teachers, public health officials, and others could provide in-service training that could enhance the abilities and knowledge of a lifeguard. In addition to providing the required in-service training, LIFEGUARD SUPERVISORS and managers should be able to draw upon subject matter experts with expertise in areas that, in their professional opinion, would provide instruction related to the lifeguard's responsibilities and duties.

6.3.3.4.2 In-Service Documentation

Documentation is maintained at the AQUATIC FACILITY to provide a method for the AHJ to verify compliance during an inspection. Documentation is crucial to prove that the in-service training took place, and this

documentation should include a list of the topics covered, who was in attendance, and the date and time of the training.

6.3.3.4.3 In-Service Training Plan

Requiring QUALIFIED LIFEGUARDS to have the ability to respond to a victim and complete a rescue is critical. To not specify this requirement would allow a QUALIFIED LIFEGUARD to demonstrate the individual skills but not necessarily do all the skills in consecutive order to complete the whole rescue. Physical fitness is a critical part of performance when conducting a rescue. QUALIFIED LIFEGUARDS who are newly certified must maintain their physical fitness and skill proficiency throughout the term of their certificate as those skills can be called upon at any time. The required level of physical fitness can be determined by several means. Schultz and colleagues showed that to do CPR at 80 compressions a minute *(training now requires 100 compressions a minute)* over a 10 minute period of time, the METS required to perform this task was 4.6 ± 0.7.[335] One would expect this number to increase using the current protocol for CPR. METS values are used for a variety of activities that lifeguards might be expected to perform.[336-338] For example, if someone swims 500 yards *(457 m)* in 10 minutes, they exert 8 METs/min *(so, almost double that for CPR cost discussed above)*. Similar levels of exertion are given by:

- Running at 5 mph on a level grade *(running 1 mile [1.6 km] in 12 min or 0.8 mile [1.3 km] in 10 minutes)*
- Riding a bicycle at 14 mph on level grade *(riding 2.3 miles [3.7 km] in 10 minutes)*

If the metabolic cost of doing CPR is about 4.75 METS, then lifeguards, who can do the above tasks, should be able to do CPR almost indefinitely, because the metabolic cost of doing CPR is only 60% of the cost of the above exercise. Importantly, this means that when doing CPR, the metabolic cost is not so intense that they will increase the amount of lactate in their blood *(i.e., they won't go above lactate threshold)*. If they stay below lactate threshold *(60-65% max intensity)* they should be able to do CPR for a long time.

6.3.3.4.5 Competency Demonstration

The point of this section is to have the skills performed consecutively and not individually as they might be done in some training classes. If all these skills cannot be done consecutively, it is difficult to expect a successful rescue. This is not intended to preclude scenario-based activities that accomplish the same.

6.3.3.5 AHJ Authority to Approve Safety Plan

Some jurisdictions will have the resources to review the SAFETY PLAN and others might not. These line items allow for that flexibility but as a matter of enforcement, the submittal of the SAFETY PLAN is required in either scenario. Should an incident occur in which the jurisdiction is investigating, the SAFETY PLAN on file would be a good point of reference. There needs to be a SAFETY PLAN that is retained and available for review by the AHJ as a point of reference detailing the intended operation to compare with the operation observed in the field.

6.3.3.5.1 Safety Plan on File

The SAFETY PLAN itself should be a tool for facility staff to utilize and as such should be present at the AQUATIC FACILITY and not merely a book sitting on a shelf in an administrative office.

6.3.3.5.2 Safety Plan Implemented

These MAHC sections are written to be performance-based; since each AQUATIC FACILITY is different, each SAFETY PLAN may be different. The SAFETY PLAN is developed to be a written document that establishes the processes the AQUATIC FACILITY will employ to be compliant with the CODE. It is important to also put in the CODE that those processes, although written, are also practiced and documented for the AHJ to see and compare the operation with what is written in the SAFETY PLAN to determine if it is compliant with the CODE. During routine inspections, the AHJ might want to see the SAFETY PLAN for the AQUATIC FACILITY as a point of reference but also to enforce a requirement of the CODE to have a plan.

6.3.4 Staff Management

6.3.4.3 Lifeguard Staff

6.3.4.3.1 Minimum Number of Lifeguards

Parts of AQUATIC VENUES or additional AQUATIC VENUES within the same AQUATIC FACILITY might not be open at all times during any given day. For example, only three lanes of a large POOL might be open during early morning lap swim. All zones of PATRON surveillance must be staffed unless the AQUATIC FACILITY can effectively limit access to only the lap lanes. A potential problem arises though, when the entire POOL is not under surveillance because a PATRON in the open section could move to a section/zone not intended to be open. Without surveillance, it may go unnoticed. So, the ability to restrict access and MONITOR or otherwise ensure that no one enters the un-opened section/zone must be able to be effectively addressed and those details must be included in the SAFETY PLAN.

AQUATIC VENUES providing a minimum of two (2) QUALIFIED LIFEGUARDS present and available ensures the minimum requirements for a facility to respond to aquatic emergencies, rotation practices, alternation of task objectives, and comply with the intent of the SAFETY PLAN in general. Single lifeguard facilities do not allow for any single lifeguard to successfully perform skills for extrication of a suspected neck or back injured patron or for an unresponsive patron in the water, nor the ability to utilize all resuscitation equipment effectively *(AED/Oxygen/BVM)* requires more than 1 rescuer. Lifeguard training agency protocols and curricula do not support single guard extrication. By having a single lifeguard on-duty we are putting a lifeguard in a position to perform outside of their training and certification. Additionally, performing effective compressions is difficult to maintain for more than a few minutes, and the presence of at least one person to take over compressions creates a cycle of rest. Reliance on non-certified individuals and/or with persons who are not present on or near the pool deck will cause delay in provision of care or perhaps ineffective or detrimental care.

6.3.4.3.2 Lifeguard Responsibilities

QUALIFIED LIFEGUARDS are the frontline personnel at an AQUATIC FACILITY, and witness most of the situations in which an AQUATIC FACILITY or AQUATIC VENUE should be closed. The QUALIFIED LIFEGUARD must be aware of these emergency closure issues to enforce them – examples include an inability to see the bottom or main drains, fecal incidents, severe weather, and others delineated by the MAHC. Since there is no established guideline for vision needed for the job of a QUALIFIED LIFEGUARD if an individual QUALIFIED LIFEGUARD has corrected vision via lenses, then s/he should wear them while conducting PATRON surveillance. Further research needs to be done in this area. Some professions require a minimum vision STANDARD non-corrected while others accept corrected vision to a certain level.

6.3.4.3.3 Water Depth

If a training agency issues a shallow water certification, the shallow water lifeguard is not qualified to be stationed in a zone that has a water depth greater than that identified for the certification. If any part of the zone has a depth of water greater than that depth, the shallow water lifeguard is not qualified to be assigned to that zone.

6.3.4.3.4 Direct Surveillance

The factors of recognition, intrusion, and distraction have been identified as major contributor to drowning in guarded venues. Nothing should be allowed to interfere with a lifeguard's duty to perform PATRON surveillance. The MAHC agreed that QUALIFIED LIFEGUARDS performing PATRON surveillance should not be doing other tasks that could distract them. When on duty, a QUALIFIED LIFEGUARD should scan and supervise the AQUATIC VENUE with no other distracting activities such as cleaning, water testing, and minimizing unnecessary conversations with PATRONS.

6.3.4.3.5 Distractions

When QUALIFIED LIFEGUARDS are engaged in conversations while performing PATRON surveillance activities, their attention is distracted from surveillance. Analogously, research has shown that even hands-free cell phone conversations can cause drivers to be distracted.[339, 340]

6.3.4.4 Supervisor Staff

6.3.4.4.1 Lifeguard Supervisor Required

The LIFEGUARD SUPERVISOR fulfills the role of making QUALIFIED LIFEGUARDS accountable for performing well and making sure the rotations are conducted properly. It is critical that QUALIFIED LIFEGUARDS perform their duties as trained and that the risk factors that affect the QUALIFIED LIFEGUARD's ability to perform have been mitigated. In addition, someone should be responsible for maintaining equipment and knowing when an AQUATIC FACILITY should close and how to mitigate hazards. This level of skill is different from that of the QUALIFIED LIFEGUARD, and each of these skills is important to have onsite anytime the AQUATIC FACILITY is open. The MAHC considered requiring a LIFEGUARD SUPERVISOR for all AQUATIC FACILITIES; but for small facilities with only one or two guards, there is no requirement. A single QUALIFIED LIFEGUARD doubling as a supervisor would be a redundancy. The SAFETY PLAN should address the means of providing oversight and direction to QUALIFIED LIFEGUARDS at single guard facilities.

6.3.4.4.2 Designated Supervisor

For any AQUATIC FACILITY, someone must be designated to make decisions and provide oversight of expected performance. When an AQUATIC FACILITY is required to have two or more QUALIFIED LIFEGUARDS, one of the QUALIFIED LIFEGUARDS may be designated as the LIFEGUARD SUPERVISOR as long as they comply with the training requirements. The QUALIFIED LIFEGUARD cannot fulfill LIFEGUARD SUPERVISOR duties while on scanning duty. For small AQUATIC VENUES, the MAHC was sensitive to requiring an additional person simply to be the LIFEGUARD SUPERVISOR. In this scenario, one of the QUALIFIED LIFEGUARDS is designated as the LIFEGUARD SUPERVISOR to make decisions when appropriate.

6.3.4.5 Emergency Response and Communications Plans

6.3.4.5.1 Emergency Response and Communication Plan

Chemical STORAGE and EAP or evacuation information also must be filed with local fire or hazmat agency according to quantities and chemical types stored.

6.3.4.5.5 Training Documentation

It is recommended that EAP drills are conducted with the staff on a quarterly basis as specified by the American Heart Association; however, each AQUATIC FACILITY is unique. Some AQUATIC FACILITIES might only be open during specific seasons, etc.

6.3.4.5.8 Communication Plan

6.3.4.5.8.2 Notification Procedures

Refer to EPA 550-B-01-003 at https://www.epa.gov/epcra/epcra-guidance-documents-and-fact-sheets

6.3.4.5.9 Inclement Weather Plan

It is recommended that employees MONITOR real time weather sources along with other techniques recommended by organizations such as NOAA. Also, include guidance on securing equipment in preparation for inclement weather. Consider having an evacuation plan to relocate PATRONS to a safe location during the storm. Be prepared by MONITORING weather and closing the AQUATIC FACILITY in time to evacuate.

6.3.4.6 Remote Monitoring Systems

Remote MONITORING systems may be used as an additional tool to help protect health and SAFETY but are not to replace or substitute for aquatics staff or their duties.

6.3.4.6.1 Lifeguard-Based

A remote SAFETY MONITORING system is an added value but should not be a substitute for having a lifeguard present when conditions deem that a lifeguard is necessary. The following excerpts from YMCA guidance provide an overview and discussion of lifeguard-based remote SAFETY MONITORING systems:

- "Speed is critical in recognizing and responding to aquatic emergencies. Time lost in the recognition phase of an EMERGENCY ACTION PLAN can prevent lifeguards from quickly reaching a swimmer in trouble and reduces the likelihood of a positive outcome. Appropriate protocols, combined with

aquatic SAFETY technology, such as a surveillance system or alarms, *[can]* save valuable time during an emergency.

- "The following are types of aquatic SAFETY technology currently available on the market:
  - **Video Camera Surveillance Systems** Underwater and surface video MONITORING systems can help analyze activity in the AQUATIC VENUE and be used to assist lifeguards in MONITORING swimmers. Some systems can alert the lifeguard when a swimmer is in trouble.
  - **Wireless Alarm or Water Activated Alarms Systems:** A water-activated alarm or wireless sensor button is a portable aquatic emergency summoning device. Such a device allows the lifeguard or others to be notified almost immediately to a potential aquatic emergency. Lifeguards can immediately respond, rather than having to first travel to the emergency call button and counselors and day care staff can immediately notify lifeguards of an unintentional submersion.
- "These technology systems DO NOT replace the need for continuous lifeguard surveillance, but they can assist a lifeguard in [his/her] surveillance duties. Use of these systems requires assessment and evaluation of current emergency protocols to incorporate the system within your EMERGENCY ACTION PLANNING. Integration of technology requires new approaches to lifeguard in-service training programs to emphasize recognition, surveillance, and prevention of over reliance on technology. Additionally, plans to address power outages or other system failures should be developed."[341]

6.3.4.6.2 Operator-Based

Operator-based remote water quality MONITORING systems can be useful in conjunction with manual testing of the water in an AQUATIC VENUE but should not be used instead of manual testing.

6.3.4.7 Employee Illness and Injury Policy

Open wounds *(such as from surgery or a piercing)* can become entry points for pathogens and are the greatest risk to the wounded person. Water-related work could be allowed with healthcare provider approval or if the wound is completely covered with an occlusive, waterproof bandage.

6.4 Aquatic Facility Management

Facility management is critical in preventing illness and injury as summarized in this section. The CDC identifies the most frequently reported contributing factors to the spread of infectious pathogens that cause RWIs, gastroenteritis in particular. Another report identified the most frequently reported type of RWI outbreak as acute otitis externa (i.e., swimmer's ear) and gastroenteritis. The incidence of these illnesses are increasing.[121] Prevention of RWIs at treated venues requires POOL operators to:

- Maintain appropriate proper DISINFECTANT concentration and pH to help maintain DISINFECTANT effectiveness, and
- Ensure optimal water circulation and filtration.

A study of POOL inspection data underscored the need for improved maintenance.[1] A total of 5,139 *(11.8%)* of 43,636 inspections identified serious violations that threatened the public's health and resulted in immediate POOL closure. Of 42,891 inspections, 3,927 *(9.2%)* identified DISINFECTANT concentration violations; of 40,533 inspections, 5,017 *(12.4%)* identified pH violations. Automated chemical feeder violations were documented during 2,378 *(6.2%)* of 38,401 inspections. Only two *(13%)* of 16 included datasets included only immediate closure data. The process of submitting, reformatting, STANDARDIZING, and analyzing these data highlighted several areas where the collection and STORAGE of AQUATIC FACILITY inspection data could be improved. To optimize collection and analysis of AQUATIC FACILITY inspection data and thus utility in informing program planning, implementation, and evaluation—a collaboration of tribal, federal, territorial, state, and local partners from different disciplines is needed. This collaboration should include environmental health practitioners with technical knowledge about the operation and management of public AQUATIC FACILITIES and with inspection experience, epidemiologists skilled in conducting surveillance and data analysis, and information technology specialists with expertise in database construction. This collaboration could provide input on identifying public AQUATIC FACILITY CODE elements deemed critical to protecting public health and on the creation of needed resources *(e.g., STANDARD inspection forms,*

training for inspectors, criteria for the construction of databases, and of tools to analyze data). Kiddie/WADING POOL inspections had the highest percentage of immediate closures *(21.6%)*. Inspections of kiddie/WADING POOLS identified the highest percentage of DISINFECTANT concentration violations *(19.2%)*, followed by inspections of interactive water play venues *(10.1%)*. See MAHC Sections 1.2.1 (RWI Outbreaks), 1.2.2 (Significance of *Cryptosporidium*), 1.2.3 (Drowning and Injuries), and 1.2.4 (POOL chemical injuries) for further discussion and background. The information identified in these reports, along with existing recreational water–associated injury data and firsthand inspector experience, drove the development of the critical risk factors for recreational water–associated injury and illness in and around AQUATIC VENUES. The eight broad critical risk factors for recreational water illness and injury are:

- Management, supervision, training, and operation
- Lifeguard services
- DISINFECTANT residual
- pH *(low or high)*
- Water clarity
- Facility ENCLOSURE/preventing unsupervised or unauthorized access
- Entrapment protection
- Water supply/waste disposal

Low concentration or absent DISINFECTANT leads to reduced inactivation of pathogens and these conditions have been associated with infectious disease outbreaks.[203] Low pH has been associated with loss of dental enamel[342-344]. Dental erosion begins to occur below pH 6.0 and rapidly accelerates as the pH drops. High pH reduces the efficacy of CHLORINE-based DISINFECTION by reducing the amount of molecular HOCl, the active form that is available for DISINFECTION. At pH 7.0, about 70% of the HOCl is molecular, at pH 7.5 about 50% is molecular, at pH 8.0 about 20% is molecular, and at pH 8.5 only 10% is molecular. As a result, upper and lower limits were set for pH *(recommended pH range 7.0–7.8)* as an IMMINENT HEALTH HAZARD.

6.4.1 Operations

6.4.1.1 Operations Manual

6.4.1.1.1 Develop

The facility design consultant can provide valuable assistance with preparation of a manual based on their knowledge of the physical system. The facility owner/operator must provide their preferences for operation and maintenance activities, based on location, climate, programs, budget, etc.

6.4.1.1.2 Include

A manual for the operation of AQUATIC FACILITIES should be kept at the facility, in both printed and digital formats. The manual should include basic information, chemical data, and operation and maintenance instructions about each POOL, SPA, and INTERACTIVE WATER PLAY AQUATIC VENUE at the facility. The manual should be updated on a regular basis to include added features, renovation work, and new CODE requirements.

Safety Related Info

PATRON and staff SAFETY are paramount to responsible operation of an AQUATIC FACILITY. Provide SAFETY related information in the operations manual including, but not limited to the following:

- Diving, drowning and electrocution hazards and risk reduction procedures
- SAFETY signage locations and message information
- Chemicals *(type and quantity stored, SDS information, delivery procedures)*
- Chemical SAFETY equipment and procedures
- Emergency procedures for staff
- Emergency procedures for PATRONS
- Inventory of PATRON SAFETY equipment *(first aid kit, backboard, head restraints, rescue tubes, throw ropes, rescue pole, etc.)*

- Fire SAFETY equipment locations, operation, and Public Safety Department notification plan *(fire extinguishers, hydrants, sprinkler system)*
- Staff training and practice drill schedule and procedures
- Electrical system, controls, and GFCI's
- Lighting and ventilation system description and controls
- Vehicle and pedestrian accessibility
- Lightning and storm evacuation plan
- Emergency phone location and access
- Emergency plan for evacuation and area notification
- Injury log

Aquatic Venue Info

Key criteria for each AQUATIC VENUE should be summarized including, but not necessarily limited to the following:

- Basin materials *(wall and floor structures, gutter system)*
- Coating materials
- Flotation protection *(underdrain system, sump pump, hydrostatic relief valves, etc.)*
- Surface area *(square feet of water or PERIMETER DECK for interactive water AQUATIC VENUES)*
- Volume *(gallons)*
- TURNOVER period *(TURNOVERS per day)*
- Recirculation rate *(GPM)*
- Filter loading rate *(GPM per square foot of filter surface area)*
- Special features flow rates *(GPM for SLIDES, sprays, LAZY RIVERS, current channels, vortex areas, surf features, play features, etc.)*

Chemical Data

The operations manual should also provide chemical data for each chemical system in the facility. This includes but is not necessarily limited to the following:

- Description of chemicals provided for primary DISINFECTANT, pH adjustment, alkalinity adjustment, stabilizer, SUPERCHLORINATION, coagulant, filter aid, etc.
- SECONDARY TREATMENT description, if provided *(UV, ozone, other)*
- Type of chemical feed equipment and rated capacities
- Discussion of water treatment goals and range of chemical targets
- Description of chemical testing equipment
- Testing frequency and location for each test
- Chemical controller information, probe cleaning, and calibration procedures
- Water testing log forms for chemical results
- Chemical supplies *(STORAGE quantity, providers, SAFETY procedures)*

Facility Operation Info

The operations manual should also provide instructions for AQUATIC FACILITY operations. These instructions should include, but not necessarily be limited to the following:

- Filter backwash or cleaning schedule and procedure
- Periodic vacuuming and cleaning schedule and procedures
- Seasonal cleaning procedures
- SUPERCHLORINATION basis and procedure
- Controller sensor maintenance *(if applicable)*
- Preventive maintenance tasks and schedule
- Winterizing procedures
- Start-up and closing procedures

Maintenance Instructions

The operations manual should provide instruction for proper maintenance for the facility. Both daily and seasonal or periodic maintenance will be required for the AQUATIC FACILITY. Available time and budget must always be balanced with the maintenance need. Regardless of whether the facility is large or small, frequent maintenance is more effective and more efficient than waiting until a larger problem occurs.

- Provide an inventory of available maintenance equipment and materials;
- Develop a daily maintenance schedule;
- Develop a schedule for periodic or seasonal maintenance; and
- Create a maintenance log with date and activity for future planning and budgeting.

Office Management

The operations manual also provides office management information for the facility. This manual should include, but not be limited to the following:

- Active and inactive records and general file information
- Forms for water test results and filter cleaning frequency
- Forms for inventory of chemicals, equipment, cleaning supplies, etc.
- Maintenance inspection forms for facility, equipment, and structures
- Maintenance work forms
- Requisition forms for purchasing based on facility policies
- Staff evaluation forms log
- POOL operation log *(water quality, attendance, weather, open hours, injuries, complaints, equipment issues, etc.)*
- Security *(opening and closing, underwater lighting, overhead lighting, doors, windows, alarms, bank deposits, etc.)*

Personnel Records

Accurate records should be maintained for all personnel. The options for this category are varied and numerous. The following list of personnel items is offered as an outline and a starting point for developing an operations manual including, but not limited to the following:

- Staff qualifications and job descriptions
- Payroll procedures
- Facility policies
- Schedules and work attendance
- Vacation and sick leave
- Benefits
- Conferences and education
- Training programs
- Termination basis
- Accident prevention

Budget Considerations

An accurate and feasible budget is critical for ongoing AQUATIC FACILITY operation. Budget considerations should be included, but not limited to the following:

- Program fees and policies
- Rental rates and policies
- Staff wages and benefits
- Facility expenditures for utilities, chemicals, concession supplies, equipment, training and program supplies, repairs and maintenance, insurance, and office administration
- Financial report including monthly and annual summaries, projections, and trends

6.4.1.4 Illness and Injury Incident Reports

Injuries and illnesses can occur outside normal office working hours; therefore, a 24/7 system for reporting and responding to injury and illnesses at AQUATIC VENUES must be maintained. Early reporting and intervention could reduce the spread of illness or prevent additional injury.

6.4.1.4.3 Notify the AHJ

The AQUATIC VENUE owner/operator should immediately report to the permit issuing official any injuries or exposures resulting in death or that require emergency medical response, resuscitation, or transport to a healthcare facility, chemical decontamination, or any illness suspected of being associated with bathing water quality or use of the AQUATIC FACILITY. The AQUATIC VENUE owner/operator will have posted and available for use the routine phone numbers and after-hours phone numbers necessary for reporting to the permit issuing official. This will facilitate a rapid investigation of the incident and could result in limiting further spread of infectious pathogens that cause disease and additional injuries. Most jurisdictions have some reporting requirements. This section is more comprehensive than the existing reporting requirements of many jurisdictions. Prompt reporting of major injuries or waterborne illness allows for the permit issuing agency to immediately assess the conditions at the AQUATIC VENUE to determine if it can continue to operate safely or must be closed. Prompt reporting and investigation also allows for more accurate investigations to determine the causes of injury and illness. This information can be used to prevent future injuries or illness.

6.4.1.4.4 Lifeguard Rescue Records

The AQUATIC VENUE owner/operator shall keep accurate records of all lifeguard rescues. A rescue is helping a BATHER that would not be able to get to the AQUATIC VENUE surface or to the DECK without lifeguard intervention or would result in activation of the EAP. An assist occurs when a guest is helped by the lifeguard in the water or from the DECK while the lifeguard still maintains surveillance of their assigned zone. The EAP is not activated for an assist. Reports and records of assists are not required to be kept.

6.4.1.6 Daily Water Monitoring and Testing Records

These duties include but are not limited to:

- Measure and record *(or supervise and ensure the measurement and recording of)* all information as required by MAHC operations, testing, MONITORING, and reporting requirements;
- Maintain the filtration and RECIRCULATION SYSTEM as required to maintain minimum flow rates required by MAHC 4.7.1 and 5.7.1;
- Backwash the filtration system when the filter gauge pressure differential reaches a level specified by the equipment manufacturer or as specified in the MAHC 4.7.2 and 5.7.2;
- Maintain DISINFECTANT residuals according MAHC 4.7.3 and 5.7.3;
- Maintain water chemistry according to MAHC 5.7.3;
- MONITOR water temperature to ensure it is within range specified in MAHC 5.7.4.7;
- Clean accessible AQUATIC VENUE surfaces as necessary to remove slime/biofilm accumulation;
- Add replacement water as needed to meet all MAHC requirements; and
- Ensure HYGIENE FACILITIES are clean, sanitary, and supplies needs for swimmer hygiene such as toilet paper and soap or hand sanitizer are available for use as per MAHC 5.10.

6.4.1.8 Body Fluids Remediation Log

See the Fecal, Vomit, and Blood Provisions in MAHC 6.5 for specific STANDARDS. For the CDC protocol for cleaning body fluid spills from POOL DECKS, visit the CDC Healthy Swimming website at https://www.cdc.gov/healthy-swimming/response/responding-to-blood-and-vomit-in-the-pool.html.

6.4.1.8.1 Contamination Incidents

The Body Fluid Contamination Response Log is an important part of the administrative procedures for the venue and will document, in the case of a fecal, vomit, or blood contamination incident, that an appropriate response occurred. A sample Body Fluid Contamination Response Log is provided below:

Body Fluid Contamination Response Log

Person Carrying out Contamination Response		
Supervisor on Duty		
Date of Contamination Response *(mm/dd/yyyy)*		
Time of Response		
Location Contaminated		
Number of People in Water *(if applicable)*		
Type/Form of Contamination: *Fecal Incident (Formed Stool or Diarrhea), Vomit, Blood*		
Time that Contaminated Area Was Closed		
Is Stabilizer Used in Water Feature *(Yes/No) (if applicable)*		
If Yes, Stabilizer Concentration at Time of Contamination Response		
Date that Contaminated Area was Reopened *(mm/dd/yyyy)*		
Time that Contaminated Area Was Reopened		
Total Contact Time *Time from when disinfectant reached target concentration to when disinfectant levels were reduced prior to opening*		
Remediation Procedure(s) Used and Comments/Notes		

Water Quality Measurements ***Columns 1-4 are measurements spread evenly through the closure time.***	**Value at Closure**	**1**	**2**	**3**	**4**	**Value Prior to Reopening**
Free Residual Chlorine						
pH						

6.4.2 Patron-Related Management Aspects

6.4.2.1 Bather Count

6.4.2.1.1 User Guidelines

Overcrowding can interfere with visual surveillance, the ability to quickly evacuate, and response times. Maximum capacities are established for AQUATIC VENUES. Knowing and enforcing capacities minimizes

overcrowding. MAHC 6.4.2.2.3 and 6.4.2.2.3.5 allow larger facilities with multiple AQUATIC VENUES to address individual aquatic attraction capacities in their signage.

6.4.2.2 Signage

The purpose of these requirements is to limit injuries and the spread of pathogens. The wording used is not prescriptive since it is the intent that must be covered; this allows managerial creativity to be used as long as the intent of the wording is conveyed. Healthy swimming messages can also be put on posters to be hung in bathroom stalls, at the AQUATIC FACILITY entrance, on the back of ticket stubs, and in group-event contracts. Ideally, signage should be provided to encourage BATHERS to take a second SHOWER after using the toilet and before reentering the AQUATIC VENUE. While this requirement might be difficult to enforce, the posting of such signs may encourage compliance or, at a minimum, raise awareness about the importance of BATHER hygiene. Consider the needs of PATRONS and staff and provide effective communication which could include signs in more than one language, Braille, etc.

6.4.2.2.3 Sign Messages

Need for adult supervision: The American Academy of Pediatrics, Policy Statement- Prevention of Drowning[345] states: Whenever infants and toddlers *(or weak swimmers)* are in or around water, be it in a POOL or an open BODY OF WATER, a supervising adult with swimming skills should be in the water, within an arm's length, providing "touch supervision." With older children and better swimmers, the eyes and attention of the supervising adult should be constantly focused on the child, and the adult should not be engaged in other distracting activities that can compromise this attention, such as talking on the telephone, socializing, tending to chores, or drinking alcohol. The term and implications of requiring "touch supervision" needs further exploration. Although it might be appropriate for some children at some AQUATIC FACILITIES, it might not be appropriate at other AQUATIC FACILITIES. Regardless of whether the term is used, it is good practice for each AQUATIC FACILITY to set a minimum age under which parental/caregiver supervision is required. Suggested content for WATERSLIDES should also include content on their signs to comply with the manufacturer's recommendations. Minimum content should include:

- Rider position,
- Number of riders allowed at a time,
- Dispatch instructions,
- Water depth at SLIDE exit,
- Weight limit as established by manufacturer, and
- Height requirement if specified by manufacturer.

For sign message #13: ("No animals in the AQUATIC VENUE and no animals on the DECK, except service animals, if applicable"), this exception applies to the DECK, not for the POOL water. Service animals are regulated under the Americans with Disabilities Act *(ADA)*. An ADAAG interpretation found on ADA's "Frequently Asked Questions about Service Animals and the ADA," found at https://www.ada.gov/regs2010/service_animal_qa.html#misc. See question 33 below:

- Question: Are gyms, fitness centers, hotels, or municipalities that have swimming POOLS required to allow a service animal in the POOL with its handler?
- Answer. No. The ADAAG does not override public health rules that prohibit dogs in swimming POOLS. However, service animals must be allowed on the POOL DECK and in other areas where the public is allowed to go.

6.4.2.2.3.7 Spa Signs

See discussion on temperature and relevant data pertaining to SPA temperatures in MAHC 5.7.4.7.2. These data have been used to support wording for SPA venue signs regarding use by young children and pregnant women.

Suggested Spa Sign Content

- Post signs with suggested time limits *(15 minutes)*.

- It is recommended that all SPAS have the following statement included on the signage. "Depth of SPA is variable. Enter with caution;"
- Other suggested SPA and SAFETY equipment
- Place time clocks with numbers large enough to read from a distance on a nearby wall in clear view of all users.
- Place a thermometer on the wall with numbers large enough to read from a distance or place the thermometer in the SPA itself.
- Place a 15-minute timer on the water jets. The reset button should be placed at least 10 feet *(3 m)* from the tub so users must physically leave the tub to turn the water jets on again.

Infants and Toddlers

Infants and toddlers should not enter SPAS. Small children are still developing the ability to regulate internal body temperature, and infants, particularly have a small body mass compared to body surface area. HOT WATER also could cause hyperthermia, and a SPA seat is not designed for a small child to sit properly to keep their head above water.

6.4.2.2.5 Diaper-Changing Station Signage

Signage requirements were adapted from the diapering procedure laid out in CFOC.[346]6.4.2.3 Swimmer Empowerment Methods

6.4.2.3.1 Public Information and Health Messaging

Public education and health communication with users should be required at any INDOOR AQUATIC FACILITY. This messaging should make clear the responsibility of the user to SHOWER before entering the POOL and that they should not urinate in the POOL. It is known that urine and sweat contribute nitrogen to the POOL resulting in chloramines. By actively limiting the introduction of urine and sweat, the result should be fewer chloramines in the POOL and the air. A summary of health and exposure data can be found in MAHC Appendix 1: Summary of Health and Exposure Data for Chemical and Biological CONTAMINANTS.

6.4.2.3.2 Post Inspection Results

There are only a relatively small number of municipal organizations that require public or web-based disclosure of inspection reports. However, as inspection activity is taxpayer-supported, there is a growing trend toward requiring public disclosure. One recent example is the Beaches Environmental Assessment and Coastal Health *(BEACH)* Act of 2000, a federal act which requires public disclosure of coastal beach closings. Additionally, DeKalb County, Georgia requires the public posting of inspection results for AQUATIC FACILITIES as well as posting them on the internet, which is like the ever-expanding requirement for posting inspection results at food service establishments. The posting of inspections at AQUATIC FACILITIES will increase public awareness of aquatic SAFETY and health and encourage aquatic operators to comply with all CODE requirements. Most jurisdictions require the permit to be conspicuously posted. This is to inform the public that the facility has met the minimum SAFETY STANDARDS required by law.

6.5 Fecal/Vomit/Blood Contamination Response

The following discussion gives the rationale behind the remediation recommendations. Fecal contamination of recreational water is an increasing problem in the United States and other countries. Since the late 1980s, the number of outbreaks of diarrheal illness associated with recreational water has been increasing in the United States.[121] Of these outbreaks, public *(non-backyard)* AQUATIC VENUES, the target of the MAHC, have had the greatest increase. These outbreaks are usually the result of BATHERS having infectious, pathogen-containing diarrhea caused by pathogens such as *Cryptosporidium*, *Giardia*, *Shigella*, *Salmonella*, or *E. coli* O157:H7. If water contaminated by the BATHER sick with diarrhea is subsequently swallowed by other BATHERS, the pathogens continue to spread and cause diarrheal illness. Diarrheal illness is common in the United States with surveys indicating that 7.2–9.3% of a person or people has had diarrhea in the previous month.[347] Additional studies demonstrated that people routinely have a mean of 0.14 grams *(range: 0.1–10 grams)* of fecal contamination on their buttocks and peri-anal surface.[218] The increase in outbreaks, the high prevalence of diarrheal illness in the public, and likelihood of frequent fecal contamination of POOLS by BATHERS raised the question of how to respond to overt fecal releases, particularly formed stools that were

more visible, in POOLS. The need to develop a response plan was amplified by the emergence of the CHLORINE-tolerant parasite *Cryptosporidium,* the leading cause of treated recreational water–associated outbreaks of diarrheal illness. First, formed stools were thought to be a substantially lower risk for spreading pathogens compared with diarrhea, since most pathogens are shed in the greatest numbers in diarrhea. Diarrhea was considered the worst-case contamination scenario—i.e., a high-risk *Cryptosporidium* contamination event. As a result, a response should require the extreme treatment conditions needed to inactivate *Cryptosporidium*. Formed stool was assessed as a lower risk than diarrhea but several questions remained. Should formed stools be treated as potentially infectious materials? If so, then should the stool be treated as a potential *Cryptosporidium* contamination event like diarrhea *(i.e., require longer inactivation time or increased CHLORINE concentration)* or could it be treated to inactivate all other pathogens other than *Cryptosporidium (i.e., require shorter inactivation time or decreased CHLORINE concentration)*. To collect data relevant to answering the questions above, a study to collect fecal releases from POOLS in the United States was conducted. POOL staff volunteers from across the United States collected almost 300 samples from fecal incidents that occurred at water parks and POOLS.[348] CDC then tested these samples for *Cryptosporidium* and *Giardia*. *Giardia* was chosen as a representative surrogate for moderately-CHLORINE resistant pathogens like hepatitis A virus and norovirus. Using conditions to inactivate *Giardia* would inactivate most pathogens other than *Cryptosporidium*. None of the sampled feces tested positive for *Cryptosporidium*, but *Giardia* was found in 4.4% of the samples collected. These results suggested that formed fecal incidents posed only a very small *Cryptosporidium* threat but should be treated as a risk for spreading other pathogens such as *Giardia*. As a result of these data and the discussion above, it was decided to treat formed stools as potential *Giardia* contamination events, and diarrheal stool as potential *Cryptosporidium* contamination events. It was thought that norovirus contamination posed the greatest threat from vomit contamination and that the virus would be inactivated by a formed stool response using *Giardia* inactivation times as discussed above. Further assessment also suggested that blood contamination of POOL water posed little health risk due to the sensitivity of bloodborne pathogens *(e.g., viruses, bacteria)* to environmental exposure, dilution in the water, and chlorination. In addition, AQUATIC VENUE water exposures would lack the requisite bloodborne exposure routes needed to spread the pathogens to other people.

6.5.1 Contamination Response Plan

The Fecal/Vomit/Blood CONTAMINATION RESPONSE PLAN is a vital part of the administrative procedures for an AQUATIC VENUE. All staff associated with the operation of the AQUATIC VENUE should be aware of the response plan and trained in implementation procedures. At least one responder should be available on- site during all hours of operation.

6.5.1.2 Contamination Training

6.5.1.2.1 Minimum

A staff member trained in fecal/vomit/blood contamination response should be onsite during all operational hours. OSHA discusses occupational issues related to potential bloodborne pathogen exposure in the Bloodborne Pathogens Standard, 29 CFR 1910.1030[349] with further discussion under General Guidance[350] and the OSHA Fact Sheet: OSHA's Bloodborne Pathogens Standard.[351]

6.5.2 Aquatic Venue Water Contamination Response

6.5.2.2 Physical Removal

6.5.2.2.2 No Vacuum Cleaners

Questions are often received concerning the MAHC recommendation to **NOT VACUUM** fecal material from the POOL. When the material is drawn through the vacuum, the vacuum itself is then contaminated and must be disinfected. At the present time, the MAHC is not aware of any manufacturer that has a decontamination protocol for disinfecting fecal-, vomit-, or blood-contaminated POOL vacuum units.

6.5.2.3 Treated

Many conventional test kits cannot measure DPD-FC concentrations up to 20 mg/L. Operators should use, in order of preference, a FAS-DPD titration test kit with or without dilutions using CHLORINE-free water, or use

test strips that measure DPD-FC in a range that includes 20 mg/L. For diarrheal stool contamination, the inactivation time should only be started once testing indicates that the intended free CHLORINE concentration *(20 ppm or other free CHLORINE concentration based on inactivation time in table above)* has been reached in the AQUATIC VENUE. FAS-DPD should be used instead of a color comparator DPD test. It is important that the operator use a non-stabilized CHLORINE product when raising the FREE CHLORINE RESIDUAL particularly when raising to high concentrations such as 40 mg/L. If a stabilized product such as dichlor or trichlor were used, a high concentration of CYA would remain in the POOL after the HYPERCHLORINATION process. The CYA concentration in AQUATIC VENUES can only be lowered by dilution of POOL water with make-up water. Since CHLORINE products degrade over time, it is not recommended that non-stabilized CHLORINE products be stored in case of a fecal incident. The operator could either purchase a non-stabilized product at a POOL supply store or buy unscented household bleach *(sodium hypochlorite)* product that has a label indicating it is EPA REGISTERED for use as a drinking water DISINFECTANT.

6.5.3 Aquatic Venue Water Contamination Disinfection

6.5.3.1 Formed-Stool Contamination

For *formed-stool contamination*, a free CHLORINE value of 2 mg/L was selected to keep the POOL closure time to approximately 30 minutes. Other CHLORINE concentrations or closure times can be used as long as the CT INACTIVATION VALUE is kept constant. The CT INACTIVATION VALUE is the concentration *(C)* of DPD-FC in mg/L multiplied by time *(T)* in minutes: (CT INACTIVATION VALUE = C x T).

For formed-stool contaminated water the CT INACTIVATION VALUE for *Giardia* (45) is used as a basis for calculations:

Table 6.5.3.1: *Giardia* Inactivation Time for Formed-Stool Contamination

Chlorine Concentrations (mg/L)	Disinfection Time*
1.0	45 minutes
2.0	25 minutes
3.0	19 minutes

**These closure times are based on a 99.9% inactivation of Giardia cysts by CHLORINE, at water pH 7.5 and temperature 77°F (25°C). The closure times were derived from EPA data.[229] The closure times do not consider "dead spots" and other areas of poor POOL water mixing.*

6.5.3.1.1 Pools Containing Chlorine Stabilizers

CHLORINE stabilizers such as CYA slow DISINFECTION; therefore, higher CHLORINE concentrations are likely necessary to reach the CT INACTIVATION VALUE for *Giardia* inactivation in POOLS using CHLORINE stabilizers. However, at this time there is no STANDARDIZED protocol to address this and no data determining how the inactivation of *Giardia* is affected by CHLORINE stabilizers under POOL conditions. A SAFETY value of 2 ppm DPD-FC has been incorporated until these data can be gathered.

6.5.3.2 Diarrheal-Stool Contamination

For ***diarrheal-stool contamination***, inactivation times are based on *Cryptosporidium* inactivation times. The CT INACTIVATION VALUE for *Cryptosporidium* is 15,300.[127, 219] If a different CHLORINE concentration or inactivation time is used, an operator must ensure that the CT INACTIVATION VALUES remain the same.

For example, to determine the length of time needed to DISINFECT a POOL at 20 mg/L after a diarrheal incident, use the following formula: ***C x T = 15,300***.

Solve for time: T= 15,300 ÷ 20 mg/L = 12.75 hours.

Therefore, it would take 12.75 hours to inactivate *Cryptosporidium* at 20 mg/L. See table below:

Table 6.5.3.2: *Cryptosporidium* Inactivation Time for Diarrheal Contamination

Chlorine Concentrations (mg/l)	Disinfection Time
1.0	15,300 minutes (255 hours)

Chlorine Concentrations (mg/l)	Disinfection Time
10.0	1,530 minutes (25.5 hours)
20.0	765 minutes (12.75 hours)

The CT 3-log used is for a 3-log inactivation to achieve a decrease in the concentration of OOCYSTS below one infectious dose per volume of water swallowed *(1 OOCYST/100 mL)*. Similar to the assumptions made for SECONDARY TREATMENT *(See MAHC 4.7.3.3.2.5)*, this calculation assumes a single contamination event *(e.g. diarrheal incident)* of ~100 mL could introduce 108 *Cryptosporidium* OOCYSTS into the water.[111, 112] This allows for a SAFETY factor to include smaller volume venues and still achieve the required concentration. An additional SAFETY factor not included is the impact of the filtration system since filter OOCYST removal efficacy varies widely. This might be more quantifiable in the future so that it could be included in the calculation. Volume calculations indicate that small volume AQUATIC VENUES like splash pads should be able to achieve this goal by using the CT INACTIVATION VALUE cited:

$$10^8 \text{ OOCYSTS} / 10{,}000 \text{ gallons} =$$

$$10^8 \text{ OOCYSTS} / (10{,}000 \text{ gallons X } 3785.4 \text{ mL/gallon}) =$$

$$2.64 \text{ OOCYSTS/mL} = 264 \text{ OOCYSTS} / 100 \text{ mL}$$

With the 3-log inactivation, this volume will contain 0.264 OOCYSTS per 100 mL which is below the required one OOCYST/100 mL and larger volume facilities will exceed this requirement.

6.5.3.2.1 Pools Containing Chlorine Stabilizers

CHLORINE stabilizers such as CYA slow DISINFECTION *(see MAHC Annex 5.7.3.1.3.1 for more discussion)* therefore, higher CHLORINE concentrations are necessary to reach the CT INACTIVATION VALUE for *Cryptosporidium* inactivation in POOLS that use CHLORINE stabilizers.[219] As the stabilizer concentration rises, parasite inactivation is inhibited to the point where inactivation is similar to natural decay of the parasite.[127] As a result, higher concentrations of stabilizer must be reduced to reach 3-log inactivation concentrations using HYPERCHLORINATION. Recent data show that 3-log inactivation of *Cryptosporidium* is possible with CYA concentrations of 15ppm or less.[127] A 3-log inactivation could not be achieved with 50 ppm or 100 ppm CYA. A 1-log inactivation of OOCYSTS was achieved with 50 ppm cyanurate concentrations after an average contact time of 61.9 hours with 20 ppm FREE CHLORINE RESIDUAL, for an average estimated CT INACTIVATION VALUE for 1-log inactivation of 76,500 mg min/L. With 40 ppm FREE CHLORINE RESIDUAL and 50 ppm CYA, a 1-log inactivation of OOCYSTS was achieved after an average contact time of 17.2 hours, giving an average estimated CT INACTIVATION VALUE for 1-log inactivation of 40,000 mg min/L. Increasing the concentration to 100 ppm CYA showed even more limited OOCYST inactivation, which did not differ much from natural decay curves for *Cryptosporidium* in water. Because 3-log OOCYST inactivation was achieved with 16 ppm CYA and was not achieved with 50 ppm CYA, the remediation protocol must be conducted in water with ≤15 ppm CYA. If the CYA concentration is above 15 ppm, the POOL will need to be partially drained to reduce the concentration. However, simply draining a portion of the water does not reduce the CYA concentration. If the CYA concentration is 90 ppm and 83% of the water is drained, the CYA concentration in the remaining water is still 90 ppm. The CYA concentration is only decreased when the venue is filled with fresh water. methods of reducing the CYA concentration are acceptable, as long as test data shows that the CYA concentration is at or below 15 ppm. The CHLORINE concentrations specified in the CODE must be used. Using CHLORINE concentrations other than those listed *(multiplying to get the CT using other concentrations as can be done using HYPERCHLORINATION in the absence of stabilizer)* assumes a linear response for inactivation but the data do not support linearity so only the listed concentrations are warranted. Along with the pH and FREE CHLORINE RESIDUAL, the CYA concentration should be checked and adjusted, if necessary, prior to reopening the POOL. Temperature is a critical parameter of measuring a CT INACTIVATION VALUE. Although pH changes with temperature, the more critical aspect is that inactivation of pathogens is well documented to decrease with falling temperature. As a result, the limited data available for POOLS requires the protocol to be conducted at the temperature where the data were collected, or above, as higher temperatures are known to increase the rate of inactivation. Most inactivation research on *Cryptosporidium*

has been conducted to aid drinking water treatment. As a result, the data are at lower temperatures *(e.g., 41°F [5°C] to simulate winter conditions)* and pH values *(e.g., pH 6)*, which are more typical of real-life drinking water conditions but of little benefit to AQUATIC FACILITY operation. Any data to document how a 5°C drop in temperature would impact the 3-log CT INACTIVATION VALUE at pH 7.5 is not currently available and, due to the difficulties, time, and cost of such research, may never be collected. AQUATIC VENUES with SECONDARY TREATMENT could be closed and allowed to circulate for the length of time calculated in MAHC 4.7.3.3.2 to reduce the level of *Cryptosporidium* below one OOCYST/100mL. Other AQUATIC VENUES without SECONDARY TREATMENT may choose to completely drain the water from the AQUATIC VENUE and replace with fresh water if they are unable to reduce the stabilizer concentration or hyperchlorinate. The intent is to achieve a 3-log reduction of the *Cryptosporidium* concentration. When the CYA concentration is over 15 ppm, some POOL water must be drained, and then the POOL must be refilled using the approved water source per MAHC 4.11.1, to dilute the CYA concentration to 15 ppm or less. This also dilutes the *Cryptosporidium* concentration and thereby achieves some of the desired *Cryptosporidium* reduction. If the initial CYA concentration is well over 15 ppm, the dilution of the *Cryptosporidium* concentration can be significant, up to a 0.78-log reduction at 90 ppm of CYA, as shown in Table 6.5.3.2.1 below.

Table 6.5.3.2.1: Log reduction of *Cryptosporidium* by Water Dilution based on Inital CYA Concentration

Initial [CYA] (mg/L)	% of water to drain	Log reduction
30	50%	0.30
50	70%	0.52
70	79%	0.67
90	83%	0.78

Since some of the *Cryptosporidium* reduction is already achieved by draining and refilling, the hyperchlorination step does not need to achieve the full 3-log reduction. Therefore, the inactivation time can be reduced in proportion to the amount of log-reduction achieved by draining and refilling. For example, if the starting CYA concentration is 90 ppm and 20 ppm of DPD-FC is used, the required inactivation time is 20.7 hours after 83% of the pool water has been drained and refilled and the DPD-FC concentration has been raised to 20 ppm. This is somewhat shorter than the 28 hours currently required. If the initial CYA concentration is over 90 mg/L, more than 83% of the POOL water must be drained and replaced, so that it might be more practical to completely drain the pool and avoid needing to hyperchlorinate, as allowed by MAHC 6.5.3.2.1 (3). However, if the water table is high in that location, completely draining an in-ground POOL may not be recommended, since exterior hydrostatic pressure may cause the empty POOL to be pushed out of the ground.

6.5.3.3 Vomit-Contamination

For vomit contamination, the CT INACTIVATION VALUE for norovirus is thought to be in the same range as *Giardia*, so the same CT INACTIVATION VALUES are used as for a formed stool contamination.[352]

Table 6.5.3.3: *Giardia* Inactivation Time for Vomit Contamination

Chlorine Concentrations (mg/L)	Disinfection Time*
1.0	45 minutes
2.0	25 minutes
3.0	19 minutes

**These closure times are based on a 99.9% inactivation of Giardia cysts by CHLORINE, at water pH 7.5 and temperature 77°F (25°C). The closure times were derived from EPA data.[229] The guidance does not take into account "dead spots" and other areas of poor POOL water mixing.*

6.5.3.4 Blood-Contamination

If the CHLORINE or bromine residual and pH are in a satisfactory range, there is no public health reason to recommend closing a POOL due to blood contamination. Data suggest that the risk posed by potential bloodborne pathogens is greatly diminished by dilution and normal FREE CHLORINE RESIDUAL concentrations. However, the operator may wish to temporarily close the POOL for aesthetic reasons or to satisfy PATRON concerns.

6.5.3.5 Procedures for Brominated Pools

There are no inactivation data for *Giardia* or *Cryptosporidium* for bromine or any developed protocols for how to hyperbrominate an AQUATIC VENUE and inactivate pathogens that might be present in fecal matter or vomit. Therefore, POOL operators should use CHLORINE in their DISINFECTION procedures. It should also be noted that DPD test kits cannot differentiate between CHLORINE and bromine. This is because DPD undergoes the same chemical reaction with both CHLORINE and bromine. Therefore, it is important that the bromine residual be measured before CHLORINE is added to the AQUATIC VENUE water. This bromine residual should be taken into consideration when determining that the FREE CHLORINE RESIDUAL necessary for the type of contamination has been met *(i.e., the FREE CHLORINE RESIDUAL measured minus the bromine residual should be equal to or greater than the intended FREE CHLORINE RESIDUAL)*. If a DPD test kit with a CHLORINE comparator is used; the TOTAL BROMINE residual can be determined by multiplying the FREE CHLORINE RESIDUAL by a factor of 2.2.

6.5.3.6 *Legionella* Contamination

Continued *Legionella* testing, after a Legionnaire's disease or Pontiac fever outbreak, may be considered on a case–by– case basis to ensure complete elimination of *Legionella*. The protocol is posted on the CDC website at https://www.cdc.gov/control-legionella/php/toolkit/hot-tub-module.html.

6.5.4 Surface Contamination Cleaning and Disinfection

6.5.4.1 Limit Access

Body fluids, including blood, feces, and vomit are all considered potentially contaminated with pathogens. Therefore, spills of these fluids on the POOL DECK should be cleaned up immediately. Visible contamination should be removed first, followed by DISINFECTION of the contaminated surfaces.

6.5.4.2 Clean Surface

The CDC protocol for cleaning body fluid spills from POOL DECKS entitled "Cleaning up Body Fluid Spills on Pool Surfaces" can be found on the CDC Healthy Swimming website at Healthy Swimming | Healthy Swimming | CDC. These procedures are based on hospital infection prevention guidelines.[353]

6.5.4.3 Contaminant Removal and Disposal

Currently, there are no STANDARDIZED procedures for removing CONTAMINANTS, particularly those found in biofilms/slime layers, in piping, or AQUATIC FEATURES that spray or dump water. All water features should be well drained and disinfected per manufacturer's instructions. Development of appropriate guidelines deserves further investigation and data gathering.

6.5.4.4 Disinfect Surface

The efficacy of DISINFECTANTS is greatly impacted by the organic load on the surface to be disinfected. Reducing the organic load as much as possible through cleaning and removal of all visible contamination BEFORE adding DISINFECTANT is critical to successful DISINFECTION. Contact times apply only if all visible organic material has been removed before DISINFECTION.

6.6 AHJ Inspections

6.6.1 Inspection Process

The AHJ has the authority to enter the facility for both routine inspections and to investigate reports of illness and injury or follow up to received complaints. At the time of investigation, all records and facility personnel required for interviews must be available.

6.6.2 Publication of Inspection Forms

6.6.3 Imminent Health Hazard Violations

6.6.3.1 Violations Requiring Immediate Correction or Closure

IMMINENT HEALTH HAZARD violations must be corrected at the time of inspection or the AQUATIC VENUE must be closed until the violations are corrected. Whenever an AQUATIC VENUE is closed due to a public health violation, signage must be posted stating that the facility is closed due to an IMMINENT HEALTH HAZARD. Before removing the closure sign and reopening in the feature, a follow-up inspection or other evidence of correction of the violations is required to ascertain correction and re-open the AQUATIC VENUE. The factors being considered IMMINENT HEALTH HAZARDS cover known risk areas:

- Low or absent DISINFECTANT concentration leads to reduced inactivation of pathogens and these conditions have been associated with infectious disease outbreaks. For a full discussion of the use of a CYA to DPD-FC ratio please see Annex section 5.7.3.1.1. The 45:1 closure ratio was chosen to be consistent with 2018 MAHC *(3rd Edition)* operational limits of 2 ppm minimum DPD-FC when CYA is present and a maximum of 90 ppm CYA. The minimum of 1 ppm DPD-FC justification can be found in the discussion about minimum DPD-FC concentrations in 5.7.3.1.1.2.
- Low pH has been associated with loss of dental enamel. Dental erosion begins to occur below pH 6.0 and rapidly accelerates as the pH drops.(342-344) High pH reduces the efficacy of CHLORINE-based DISINFECTION by reducing the amount of molecular HOCl, the active form that is available for DISINFECTION. At pH 7.0, about 70% of the HOCl is molecular, at pH 7.5 about 50% is molecular, at pH 8.0 about 20% is molecular, and at pH 8.5 only 10% is molecular. As a result, the MAHC decided to set upper and lower limits for pH *(recommend pH range: 7.2–7.8)* as an IMMINENT HEALTH HAZARD.
- High disinfectant concentrations can lead to irritation and potential damage of the eyes, skin and mucous membranes, lungs, potentially cause dermal burns, and aggravate or trigger existing respiratory conditions such as COPD and Asthma. Chest pain, vomiting, dyspnea and cough have been identified in DPC-FC concentrations approaching 30 ppm (mg/L) and toxic pneumonitis and pulmonary edema at DPD-FC concentrations above 46 ppm (mg/L). For more information see https://www.epa.gov/sites/default/files/2016-09/documents/chlorine.pdf.
- Injuries/deaths occur to persons using equipment such as vacuums and reach poles at swimming POOLS when this equipment contacts overhead wires which are too close to the POOL.
- Clearance in any direction from the water, edge of POOL, etc. is to protect people using rescue and service equipment at POOLS, which are typically aluminum.
- Clearance in any direction to the diving platform, tower, WATERSLIDE, or other fixed POOL related structure is to protect a swimmer using these items.
- Follow-up procedure for observance of electrical lines within 20 feet *(6.1 m)* of a swimming POOL during an inspection:
    - Determine whether the electrical lines are owned by the utility company or by the owner/operator of the swimming POOL/property.
    - If they are owned by the utility company, the operator should obtain a letter from the utility company stating that these lines are in compliance with NEC 680 Standards.
    - If the lines are owned by the owner/operator, and there is no waiver or variance, it is a public health hazard.
    - This requirement does not apply to wiring inside walls/ceilings, etc. at an indoor POOL.

6.6.4 Enforcement

6.6.5 Enforcement Penalties

This is meant to apply to an AQUATIC FACILITY not making a good faith effort to correct recognized problem(s). This is not meant to apply to a closed AQUATIC FACILITY that is working on correcting an IMMINENT HEALTH HAZARD or other violation *(e.g., parts on order, maintenance scheduled)*. It is up to the AHJ to determine if an AQUATIC FACILITY is making such an effort.

7.0 Special Venues

7.1 Floatation Tanks

"Floating" is a health and wellness practice in which users float in a saturated Epsom salt solution *($MgSO_4$)*. The practice is intended to reduce sensory input through several means. The dense, highly buoyant solution allows users to float without effort, and is maintained at or near the external temperature of the skin *(93.2-95°F/34−35°C)*. The "float tanks" in which floating occurs might vary greatly in design *(ranging from open basins to chambers to pods)* but are generally designed to reduce light and sound penetration. However, some tank designs might provide sensory inputs in the form of colored lights, sounds, or aromatherapy. Although FLOATATION TANKS are typically found in commercial float centers containing multiple units, they could be installed in a range of settings. The academic literature on FLOATATION TANKS is limited. There is a growing body of research examining potential health benefits[354]. Recently, the National Collaborating Centre for Environmental Health *(NCCEH)* produced two documents related to potential environmental health risks of floating[355, 356] and an overview of guidance and lack of regulation pertaining to these devices. A second literature review of microbial risks was also produced by Public Health Ontario.[357]

7.1.1.1 Design and Construction

Due to the unique nature of the FLOATATION TANK SOLUTION and the nature of use of FLOATATION TANKS, the typical system design criteria detailed in MAHC Section 4 are not appropriate. The MAHC provisions that are applicable are individually listed. NSF International developed criteria to test and certify FLOATATION TANK systems, components and related equipment; those criteria can be found in NSF CCS-12804.[358] While developing and refining the proposed requirements for the MAHC, the CMAHC Floatation Tank Ad Hoc Committee identified areas of the CCS-12804 that are inconsistent with the MAHC proposals, which can cause confusion, and other areas to be considered for revision. Due to these inconsistencies and potential for further changes to CCS-12804, the Committee chose to specify only certain CCS-12804 provisions instead of requiring compliance and certification to the complete STANDARD at this time. Upon additional discussion and review of submitted comments, it was decided to remove the reference to CCS-12804 at this time while incorporating some of the specific provisions into the proposed requirements for the MAHC.

7.1.4 Floatation Tank Electrical Systems and Components

Electrical considerations and SAFETY pertaining to the equipment used in and around the salt solution was deemed extremely important. Therefore, the National Electrical Code was referred to and the FLOATATION TANK and room containing a FLOATATION TANK was deemed to be a wet and CORROSIVE environment with respect to electrical systems and components.

7.1.8 Disinfection

The CMAHC Ad Hoc Committee considered several factors that distinguish FLOATATION TANKS from other AQUATIC VENUES when determining the minimum requirements for DISINFECTION. One key factor in pathogen transmission risk is that the potential routes of exposure are different than typical swimming POOLS. The following information is excerpted.[355, 356] "There are several aspects of FLOATATION TANKS and their typical user profile that might modify the risk of communicable disease compared with POOLS and SPAS or hot tubs. Due to the high salinity and bitter taste of the solution, clients avoid ingestion or eye contact. Water is less likely to get in the ears as many facilities provide ear plugs, although some users prefer a plug-free experience. Clients are typically advised to protect small cuts with a BARRIER of petroleum jelly to prevent stinging and are unlikely to float with open sores or wounds. Clients are also generally adults, thus reducing hygiene and fouling issues sometimes seen in other types of recreational water facilities caused by children with decreased bowel and bladder control. It should be noted that some Canadian float facilities do not exclude *(and in some cases market toward)* children. Furthermore, total daily BATHER load in a FLOATATION TANK is low *(8−12 individuals)* and constant *(1−2 people at a time)*, such that operators do not need to adjust DISINFECTANT in response to changes in use. Clients are generally naked while floating, but there is no evidence as to whether swimwear substantially affects bacterial load or has any impact on urinary tract infections. Clients are asked or required to SHOWER before using the tank, which reduces pathogen inputs, as well as organic CONTAMINANTS that contribute to DISINFECTION BYPRODUCT formation and decreased

DISINFECTION efficiency. Finally, users SHOWER after their sessions to remove the salt, which should help to reduce infection risk. "These aspects of FLOATATION TANK use likely decrease ingestion and eye contact as routes of transmission compared to compared with AQUATIC VENUES. FLOATATION TANK users do remain potentially vulnerable to skin, genitourinary, and outer ear infections. Inhalation might represent another route of transmission, as some FLOATATION TANK models agitate the water vigorously between clients; it is unclear if this might lead to the formation of bioaerosols if pathogens are present in the water. Finally, the hydrodynamics of a FLOATATION TANK, specifically the stillness of both solution and client, might also positively or negatively affect the ability of pathogens to contact, adhere to, and invade the skin. Thus, despite mitigating circumstances, a number of questions remain regarding pathogen transmission between clients in float facilities." Potential pathogens of concern, their ability to survive or thrive and corresponding acceptable DISINFECTION methods were also considered. Previous work conducted by NSF found that common indicator organisms were able to survive the highly saline conditions without reduction over the interval between two clients *(15-30 min)*, and with a less than 3-log reduction up to 24 hours later.[359, 360] Because pathogens can survive FLOATATION TANK SOLUTION over the short term, and because repeated use of the solution over many floats could further compromise water quality in a way that might promote pathogen presence, an effective sanitation system is necessary. FLOATATION TANK sanitation systems may include the use of:

1) a halogen *(CHLORINE or bromine)*, typically with ultraviolet *(UV)* light or ozone *(O_3)*,
2) O_3 with UV or H_2O_2, or
3) H_2O_2 with UV.

There is very limited data regarding the efficacy of these sanitation systems in FLOATATION TANKS specifically. Although two studies have examined the use of bromine and UV, the studies available provided limited detail regarding tank design and operation and did not provide sufficient experimental detail to assess efficacy.[361, 362] The most thorough evaluation of a FLOATATION TANK was carried out by NSF as part of the certification of an O3 / UV system according to CCS-12804, which met the DISINFECTION efficacy criteria.[363] The CMAHC Ad Hoc Committee proposed that only ozone or ozone/UV combination systems be provided for DISINFECTION, CHLORINE or bromine are not required, and use of hydrogen peroxide as a DISINFECTANT is prohibited in the MAHC. The following considerations provide rationale for this:

- CHLORINE or bromine are reportedly not EPA REGISTERED for use in FLOATATION TANKS.
- Hydrogen peroxide is not an EPA–REGISTERED DISINFECTANT or sanitizer in recreational water. Based on data summarized[355, 356] its use as a DISINFECTANT at the concentrations typically recommended for FLOATATION TANKS *(50-100 pm)* is unlikely to be effective. However, some operators use hydrogen peroxide as a water conditioner, with no claims of DISINFECTION efficacy. This use is acceptable as long as its use is consistent with EPA label requirements.
- Ability to accurately test CHLORINE/bromine residuals in the salt solution is in question, particularly at concentrations lower than 2.5 ppm[364];
- The use of FLOATATION TANKS is typically restricted to one person at a time, such that potential exposure to shed pathogens from other BATHERS, as is the case in POOLS or SPAS, does not occur during the individual float session.
- Routes of exposure *(ingestion, inhalation, contact)* are limited:
    - Ingestion *(G.I. illness)* is less likely due to manner of floating and palatability of tank water.
    - Inhalation (respiratory-*Legionella*) is likely minimal/reduced based on little or no agitation/aerosolization of tank water during use in most tank designs.
    - Contact with the skin and ear canal occurs, but eye contact unlikely or very short-lived due to extreme irritation of eyes by salt.
- Pathogens of concern might be able to persist/survive over short periods but are unlikely to readily grow in the tank water.
- Ability to adequately DISINFECT between users using ozone/UV combination or ozone
- Control of biofilm or slime through routine physical scrubbing or wiping surfaces and treatment by ozone/UV or ozone
- Requiring ozone or ozone/UV DISINFECTION systems only.

- UV alone is not acceptable due to the demonstrated resistance of some viral pathogens to UV DISINFECTION, even at relatively high doses.[365] Furthermore, UV does not provide contact DISINFECTION of surfaces at any other point in the system other than the UV cell itself. This is in contrast to O_3 treatment, which due to its relatively long half-life at 95°F/35°C *(8 min*[366]*)* could be expected to permeate all parts of the tank and plumbing.

Upon additional discussion and review of submitted comments and technical data, the proposal was amended to require either ozone or UV DISINFECTION systems, not both. It appears that the limited number of viral pathogens that demonstrated resistance to UV alone, their routes of exposure *(typically fecal/oral)*, and absence of any identified illness outbreaks from viruses associated with use of FLOATATION TANKS or SPA POOLS, which are similar in that ingestion of water is not typical, use of UV DISINFECTION systems alone is allowable at this time.

7.1.9 Ventilation

There was discussion within the CMAHC Ad Hoc Committee about potential air quality concerns within the closed FLOATATION TANK during use, such as build-up of carbon dioxide or DISINFECTION BYPRODUCTS. However, there is insufficient information at this time to determine if, or to what extent, there might be a problem.

7.2 Floatation Tank Operation

7.2.8 Treatment System–Required Operation Time

In a FLOATATION TANK, adequate treatment to mitigate the possibility of pathogen transmission must occur between users as the system does not run while a user/BATHER is in the tank. UV and ozone systems are dependent on the RECIRCULATION SYSTEM TURNOVERS to treat the tank water. Therefore, as there will be no DISINFECTANT residual in the FLOATATION TANK SOLUTION in the tank, adequate/acceptable DISINFECTION is totally reliant on consecutive dilution of the tank water CONTAMINANTS through the process of bringing the FLOATATION TANK SOLUTION to and through the filter and UV or ozone systems, 3-log reduction per pass through the DISINFECTION systems *(required ozone and UV device DISINFECTION efficacy)*, returning the FLOATATION TANK SOLUTION with reduced pathogens to the tank, etc. until an acceptable percentage of the total water in the FLOATATION TANK has passed through the ozone or UV system. Five volumetric TURNOVERS were selected which, based on Gage-Bidwell laws of dilution work, provides for 99.3% of the total volume of the FLOATATION TANK SOLUTION passing through the filter and DISINFECTION system. Upon additional discussion, review of submitted comments and technical data, the proposal was amended to require a minimum of three volumetric TURNOVERS which provides for 95% of the total volume of the FLOATATION TANK SOLUTION passing through the filter and DISINFECTION systems. This decision was based on consideration of the potential concentration of pathogens that might be expected in a FLOATATION TANK. *Pseudomonas aeruginosa*, one of the pathogens of concern/interest was used as an example to examine what concentrations could be expected in a FLOATATION TANK, the infectious dose, and other factors which could lead to infection. When looking at the studies involving whirlpools[187, 367] the worst case contamination load of the organisms brought in by the user was used, then the dilution factor, based on number of gallons typical of a FLOATATION TANK *(250 gallons)* yielded a final concentration 1000 times below the estimated threshold for infectivity. Further, the article concludes that super-hydration of the skin is the vital change required for invasion and subsequent inflammation from *Pseudomonas*. Due to the high salt concentration in FLOATATION TANK water, super-hydration will not happen. Due to osmotic pressure the changes to skin hydration are not equivalent to SPAS. This makes entry of viable and infective Pseudomonad cells into the skin even less likely.

7.2.12 Cleaning

It is important to prevent the build-up of a slime or biofilm layer so as not to provide an environment conducive to organisms such as *Pseudomonas aeruginosa* and others. This is especially important since there is no halogen residual present in the FLOATATION TANK SOLUTION.

7.2.13 Fecal/Vomit/Blood Contamination Response

FLOATATION TANK SOLUTION contamination response is being addressed separately and specific to FLOATATION TANKS due to the existing MAHC requirements is this regard being based on CHLORINE concentrations.

7.3 Artificial Swimming Lagoon (ASL) Design and Construction

7.4 Artificial Swimming Lagoon Operation and Management

7.4.2 Water Quality

7.4.2.4 Water Testing Plans

7.4.2.4.2 Water Sports Area Boaters and kayakers do have some contact with the water in water sports areas, but not in the same manner as swimmers in DSAs. All water in the ASL is being displaced from the sanitized DSA to the water sports area of the lagoon, through a positive hydraulic gradient.

7.4.2.5 Microbial Water Quality Monitoring in Water Sports Area

7.4.2.5.3 Refer to Established Methods

The state of Florida requires the following for non-swimming areas in ASLs, per Florida Building Code, Section 454.1 – Public Swimming Pools and Bathing Places:

- Tests for bacteriological levels in non-swimming areas should be performed at least once monthly.
- A set of two samples should be collected for every 500 feet of shoreline outside of any DSA.
- The samples should be taken a foot below the surface in at least 3 feet of water and at least 25 feet apart.
- Owners and operators of an ASL can test for either enterococci or E. coli bacteria.
- The enterococci density should not exceed 61 colony forming units (CFU) per 100 mL of water in any single sample.
- E. coli density should not exceed 235 CFU per 100 mL of water in any single sample of water.
- If the test results of these samples exceed the values listed above, the owner/operator should notify the AHJ within 24-hours of receiving the results, and the owner/operator should resample within 24 hours.
- All sampling results should be submitted to the AHJ.
- If resampling cannot be completed within 24 hours, or in the event the resampling results continue to exceed the bacteriological values listed above, the owner should immediately close the ASL to patrons.
- The ASL should not be reopened until additional testing reveals the water meets water quality parameters.

The state of North Carolina requires the following for non-swimming areas in ASLs, per North Carolina Health Code, 15A NCAC 18A .2543 – Water Recreation Attractions:

- Tests for bacteriological levels in non-swimming areas should be performed at least once weekly.
- One sample should be collected for every 250 feet of shoreline outside of any DSA, with no more than 300 feet and no less than 25 feet between any two sampling locations.
- The samples should be taken a foot below the surface in at least 3 feet of water.
- NC references their natural body of water recreational swimming standard (lakes and beaches) for the bacterial counts in water sports and will close if the samples exceed that standard.
- The enterococcus level shall not equal or exceed either: (1) a geometric mean of 35 enterococci per 100 milliliters of water or (2) a single sample of 104 enterococci per 100 milliliters of water.

Appendices

Appendix 1: Summary of Health and Exposure Data for Chemical and Biological Contaminants

Appendix 2: Air Quality Formula

Appendix 3: Dye Testing Procedure

Appendix 1: Summary of Health and Exposure Data for Chemical and Biological Contaminants

TRICHLORAMINE threshold research reference synopses:

- TRICHLORAMINE has a pungent CHLORINE odor, is a strong irritant, and causes excessive tearing of the eyes.[368]
- Methods for sampling include[85]
  - INRS method *[INRS 2007]*,
  - NIOSH draft methods *[method not published]* using ion chromatography *(IC)*, and
  - Inductively coupled plasma atomic emission spectroscopy *(ICP-AES)*.
- Based on concentration-response data in mice, the author recommends TLV for a short-term exposure limit *(TLV-STEL[1])* of 1.5 mg/m^3 and an allowable time weighted average *(TLV-TWA[2])* of 0.5 mg/m^3 for TRICHLORAMINE.[83]
- Health complaints from teenage swimmers and soccer players showed a significant increase in respiratory complaints at chloramine concentrations of 0.37 mg/m^3 or greater.[84]
- Symptoms, in a separate study, were not observed until the chloramine concentrations reached 0.5 mg/m^3, and everyone reported symptoms when the concentrations reached 0.7 mg/m^3.[85]
- In a study of 334 lifeguards and 63 indoor POOLS, the prevalence of mucous membrane irritation among lifeguards exposed to TRICHLORAMINE concentrations above 0.5 mg/m^3 was 86% for eye irritation, 61% nose irritation, 29% throat irritation, and 42% dry cough.[86]
- Airborne TRICHLORAMINE was measured at six indoor swimming facilities and researchers found an elevated prevalence of respiratory symptoms in swimming POOL workers. Mean TRICHLORAMINE concentration of 0.56 mg/m^3, with the highest concentration reaching 1.34 mg/m^3. General respiratory symptoms were significantly higher in POOL employees compared to the Dutch population sample *(odds ratios ranged from 1.4 to 7.2)*.[87]
- Researchers generated TRICHLORAMINES at 0.5 mg/m^3 in a challenge chamber and exposed the participants to a series of 10-minute exposures followed by spirometry. Results showed a decrease in pulmonary function.[39]
- TRICHLORAMINE is the most volatile and prevalent chloramine compound in the air around swimming POOLS[39] has low solubility, and decomposes rapidly in sunlight.
- The World Health Organization proposes a 0.5 mg/m^3 provisional value although it states that more research is needed to investigate health effects in people who use the POOL for extended periods of time and the role of TRICHLORAMINE in possibly causing or exacerbating asthma.[56]
- Although proposed STANDARDS and past studies indicate that a comfort level for indoor POOL areas would be to keep TRICHLORAMINE concentrations below 0.5 mg/m^3, there have been some concerns that this concentration may not be low enough to prevent symptoms.[86]

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[1] The short-term exposure limit or maximum concentration for a continuous exposure period of 15 minutes (with a maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided that the daily TLV-TWA is not exceeded.)

[2] The allowable time-weighted average concentration for a normal 8-hour workday or 40-hour week to which a person can be repeatedly exposed for 8 hours a day, day after day, without adverse effect.

THM threshold research reference synopses:

- Animal toxicity studies demonstrate and characterize hepatotoxicity and nephrotoxicity.[369]
- Investigation of THMs in tap water and swimming POOL water. The concentrations of total THMs in swimming POOL water was higher than those in tap water, particularly, brominated-THMs. This poses a possible cancer risk related to exposure.[370]
- Environmental and biological MONITORING of THMs was performed to assess the uptake of these substances after a defined period in five competitive swimmers. Analyses were performed by gas chromatography. In relation to biological MONITORING, $CHCl_3$, $CHBrCl_2$ and $CHBr_2Cl$ were detected in all alveolar air samples collected inside the swimming POOL.[21]
- Methods for testing halogenated hydrocarbons: NIOSH method 1003 halogenated hydrocarbons: https://www.cdc.gov/niosh/docs/2003-154/pdfs/1003.pdf; experimental method for sampling THMs - Membrane introduction mass spectrometry[371]. *Standard Method* 6232 C TRIHALOMETHANES and Chlorinated Organic Solvents (PURGE & Trap/Gas Chromatographic/Mass Spectrometric Method) in water found at: https://www.standardmethods.org/doi/abs/10.2105/SMWW.2882.121 .

Biological contamination research reference synopses:

- *Mycobacterium avium* complex *(MAC)* is reduced with higher halogen presence and higher TURNOVER RATE in hot tubs.[372]
- Mycobacteria are prevalent in POOL water and in air. They tend to aerosolize more than other POOL water CONTAMINANTS.[373]
- *Legionella* presence increased in HOT WATER, in water with pH greater than 7.8 and CHLORINE less than 0.2 ppm.[374]
- *Legionella* was more prevalent in SHOWERS than POOLS[375]. Low temperatures in SHOWERS showed higher *Legionella* prevalence. Over 109°F *(43°C)* resulted in no *Legionella*.
- For Gram negative bacteria - endotoxin levels of 14,400 in hot tub were considered a contributing factor to acute illness of BATHERS in Wisconsin.[376]
- 45 - 400 EU *(endotoxin units)*/m^3 was associated with acute airflow obstruction, mucous membrane irritation, chest tightness, cough, shortness of breath, fever, and wheezing.[377-380]
- Chronic health effects associated with airborne endotoxin exposures include chronic bronchitis, bronchial hyper-reactivity, chronic airways obstruction, hypersensitivity pneumonitis, and emphysema.[381]
- "Lifeguard lung" has been associated with indoor swimming POOL use.[80]
- A permanent decrease in pulmonary function, along with respiratory symptoms, has been reported in epidemiological studies.[382]
- The *Limulus* amebocyte lysate *(LAL)* assay used to analyze for endotoxin LAL assay, is a comparative bioassay.[382] However, changes in the LAL test procedures themselves can erroneously appear as changes in the measured endotoxin activity levels. Until problems with the LAL test are resolved, endotoxin results cannot be compared to samples collected at different times or analyzed by different laboratories. For these reasons, the American Conference of Governmental Industrial Hygienists *(ACGIH)* has proposed that RLVs[3], rather than the more usual TLVs, be used as a reference for endotoxin.[382]

[3] Relative Limit Values require that samples be collected from an area considered to represent background levels of endotoxin and be analyzed at the same time as the samples from areas of interest. The RLV is a comparison between the environment in question and background levels. ACGIH states that if health effects are consistent with endotoxin exposure, and if the endotoxin exposures exceed 10 times the simultaneously determined background levels, then the RLV action level has been exceeded, and action should be taken to reduce exposure. The proposed maximum RLV rises to 30 times the background level in an environment where no symptoms are reported. When exposures exceed the RLV action level or maximum RLV, remedial actions to control endotoxin levels are recommended. It is important to note that the nature of the relationship between the RLV and health effects has not been elucidated at this time.

Appendix 2: Air Quality Formula

NOTE: Included from 2014 MAHC (1st Edition) *Substantial numbers of public comments were received regarding the proposed increase, above ASHRAE 62 Standards of required outdoor air. The commenters noted that the requirements will result in increased costs for equipment and operation while lacking adequate data to support the increase. Based on the potential negative impact and the need for additional research and data to differentiate the causes and sources of indoor air quality problems on design criteria (e.g., design, inappropriate operation, inadequate maintenance), the MAHC Committee decided to defer to ASHRAE outdoor air requirements in this version of the MAHC. The Committee thought it important to preserve the work done by the Technical Committee, so the proposed CODE language for additional outdoor air has been moved to Appendix 2 in the MAHC along with preserving the corresponding annex discussion. A research agenda should be developed and should be a priority to better address the contributing factors to indoor air quality problems and the appropriate design and operational requirements needed to address those factors.*

INDOOR AQUATIC FACILITY AIR HANDLING SYSTEM should have a design capability to supply the minimum outdoor air requirements using MAHC Appendix 2 Table below in addition to ASHRAE 62.1:

RMAHC = Ra + Rp

Density (ft^2 / person)

Appendix 2 Table: Factors for Calculating Outdoor Air Requirements for Indoor Aquatic Facilities

Factors	Flat Water	Agitated Water	Hot Water	Deck	Stadium Seating	Modifier
ASHRAE R_a	0.48	0.48	0.48	0.48	0.06	None
Additional CFM per person (R_p)	10.0	25.0	60.0	10.0	7.5	None
Average density in the pool (sq ft/person)	20.0	15.0	10.0	50.0	6.6	Based on designer / engineer rationale
cfm / person / ft^2	0.5	1.67	6.0	0.2	1.14	
R_{MAHC} (Total cfm / sq ft)	0.98	2.15	6.48	0.68	1.2	

R_a = ASHRAE 62.1 Equivalent *(cfm / square foot)*

R_p = Occupant driven cfm/person

R_{MAHC} is the number of cfm of outdoor air required for the area.

For Example:

$R_{MAHC} = R_a + R_p$

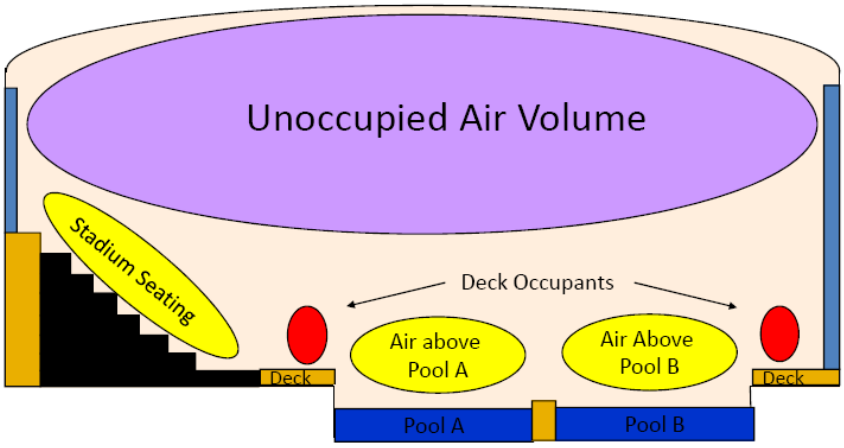
Density (ft^2 / person)

R_{MAHC} (FLAT WATER) =.48 + (10 cfm/person) = .98 cfm/ft^2

20 ft^2/person

The additional cfm per person addresses the CONTAMINANTS contributed to the air from the individuals in the POOL. This number varies based on the release of CONTAMINANTS to the air, which is dependent upon the agitation of the POOL surface and the occupant density of the various locations within the INDOOR AQUATIC FACILITY as described below and the in Appendix Figure 1.

Appendix Figure 1: Side view of a typical INDOOR AQUATIC FACILITY



- FLAT WATER – area of an AQUATIC VENUE in which the water line is static except for movement made by users. Diving spargers do not void the FLAT WATER definition.
- AGITATED WATER – area of an AQUATIC VENUE with mechanical means *(AQUATIC FEATURES)* to discharge, spray, or move the water's surface above or below the static water line of the AQUATIC VENUE. Where there is no static water line, movement shall be considered above the DECK plane.
- HOT WATER – area of an AQUATIC VENUE with a water temperature over 90 degrees Fahrenheit *(32°C)*.
- DECK – area of floor spaces at or near the same elevation as POOL surfaces often used for observation and access.
- STADIUM SEATING – area of high-occupancy seating provided above POOL level for observation. Generally, bleacher style at a higher elevation than the POOL surfaces.

The Density factor in Appendix 2 Table could be modified if the designer/engineer of the INDOOR AQUATIC FACILITY can document the intended use is different *(i.e., a swimming POOL is a FLAT WATER venue and is normally 20 ft^2 (1.9 m^2) per person, but when designing a FLAT WATER WADING POOL, which has a higher density of BATHERS, the number could be modified to15 ft^2 (1.4 m^2) per person).*

For INDOOR AQUATIC FACILITIES with more than one type of water or seating, the total outside air required is calculated by adding together the air required for each type.

The number of cfm of outdoor air for an INDOOR AQUATIC FACILITY shall be calculated with the following equation:

Area of FLAT WATER in ft^2 x FLAT WATER R_{MAHC}

+

Area of AGITATED WATER in ft^2 x AGITATED WATER R_{MAHC}

+

Area of HOT WATER in ft^2 x HOT WATER R_{MAHC}

+

Area of DECK in ft^2 x DECK R_{MAHC}

+

Area of STADIUM SEATING in ft^2 x STADIUM SEATING R_{MAHC}

=

Total cfm of required outdoor air for INDOOR AQUATIC FACILITY

Appendix 2 Table above was established to provide a guide for designers to achieve acceptable air quality while considering the main factors that affect air quality: Water treatment, THEORETICAL PEAK OCCUPANCY, and water surface area *(splashing, aeration)*.

The following outlines the discussion by the MAHC Committee. One of the goals was to establish a more comprehensive formula than is currently published in the ASHRAE 62 ventilation document *(e.g., adding additional air requirements to the minimum ASHRAE Standards)*. The formula should include consideration for the type of feature as well as what type of water treatment is being utilized to maintain the water chemistry. The Committee realized early on that there is very little research in the off-gassing of chemicals for INDOOR AQUATIC FACILITIES. ASHRAE completed a preliminary research project(383) but did not perform detailed research on various AQUATIC VENUES and treatment methods. The Committee had to use the experience of its members on what was working in the real world and what was not working to modify the formula used in ASHRAE 62. In other words, the Committee had the final answer and developed a modified formula that yielded the desired results. This formula calculated the minimum air required in ASHRAE 62 and then added additional air TURNOVER requirements depending on the type and area of AQUATIC FEATURE or DECK/spectator area.

The matrix was set up with three types of AQUATIC VENUES: FLAT WATER, AGITATED WATER, and HOT WATER as each type of AQUATIC VENUE differs in how it affects air quality. One of the key drivers that the Committee identified that made these AQUATIC VENUES different was the expected THEORETICAL PEAK OCCUPANCY density. With increased BATHERS per unit volume of water, there is an increase in the organic contamination from the POOL users and thus the presence of COMBINED CHLORINE or combined bromine. The second factor was how much surface area of the AQUATIC VENUE water would come in contact with the air to increase the expected off-gassing of chemicals.

The rationale for developing guidance related to density and AQUATIC VENUE types is as follows:

1) FLAT WATER
    a. Contribute to poor air quality only when there are BATHERS splashing, releasing TRICHLORAMINE and other DBPs into the air.
    b. These AQUATIC VENUES generally are for swimming.
    c. The density was established at 20 ft^2 *(1.9 m^2)* per person. This represents an average horizontal swimmer occupying a 5-foot by 4-foot area.
    d. Assuming a person is swimming horizontally; a full body length is an average 5 feet *(152 cm)* with a 5-foot span to equal 25 ft^2 *(2.3 m^2)*. There was a need to account for higher density in shallow areas where users wade vertically versus swim horizontally. The middle ground was decided to be 20 ft^2 *(1.9 m^2)*.
2) AGITATED WATER
    a. These are AQUATIC VENUES with AQUATIC FEATURES that mechanically disturb the water surface such as spray features, WATERSLIDES, etc. They contribute to poor air quality any time those AQUATIC FEATURES are operating. This constant introduction of DBPs into the air requires more fresh air for these venues.
    b. These AQUATIC VENUES generally are for wading and enjoyment of features without swimming.
    c. The density was established at 15 ft^2 *(1.4 m^2)* per person. This represents an average vertical user occupying a 5-foot *(152 cm)* by 3-foot *(91 cm)* area. This also complies with the Illinois State Pool Code.
3) HOT WATER
    a. These AQUATIC VENUES require more chemicals and release more DBPs due to increased chemical demand, increased introduction of BATHER waste, and increased evaporation, which deposits more DBPs into the air per square foot than any other AQUATIC VENUE. This type of feature requires the most outside air.
    b. These AQUATIC VENUES generally are for lounging such as hot tubs, warming POOLS, etc.
    c. The density was established at 10 ft^2 *(0.93 m^2)* per person. This represents an average user sitting in a 3-foot *(91 cm)* by 3-foot area.
4) DECK and Spectator Areas

a. For leisure POOLS, one can assume 50 ft^2 *(4.6 m^2)* per person based on Illinois Pool Code. Adding seating and tables, which separates groups, the square footage allows for less density.
b. For spectator area, the Committee used 6.6 ft^2 *(0.61 m^2)* per person for STADIUM SEATING from the ASHRAE 62.1 Table. This seating is generally well above the water level.

Using the ASHRAE 62.1 definitions for outside air as a baseline, and utilizing the ASHRAE method to determine minimum outside air requirements, plus adding additional fresh air depending on feature type from Appendix 2 Table, the formula is:

Minimum outside air in cfm = (Ra X AQUATIC VENUE and DECK area in ft^2) + [AQUATIC VENUE A area in ft^2 X (Rp / Density factor)] + [AQUATIC VENUE B area in ft^2 X (Rp /Density)] + [DECK area in ft^2 X (Rp/Density factor)] + (Ra X Spectator area in ft^2) + [Spectator area in ft^2 X (Rp / Density factor)]

- **R_a** = cfm of outside air needed for an aquatic space of any type without PATRONS. Using factor from ASHRAE 62.1 See Appendix 2 Table for R_a value.
- **R_p** = additional cfm needed per person occupying the AQUATIC VENUE above that calculated with R_a and ASHRAE 62.1. R_p value is based on type of AQUATIC VENUE for reasons stated above. See Appendix 2 Table for appropriate R_p value.
- **R_p** = additional cfm needed per person occupying DECK or spectator space above that calculated with R_a and ASHRAE 62.1. Occupant density differs based on DECK or spectator usage. See Appendix 2 Table for appropriate R_p value.

This calculation allows for calculating minimum outside air required for an AQUATIC FACILITY that has varying sizes and types of AQUATIC VENUES. Engineers can calculate for individual AQUATIC VENUES and DECK spaces and add them together for the entire facility.

DESIGN PROFESSIONALS experience factored into the final cfm/ft^2. DESIGN PROFESSIONALS knew from experience where the final number needed to be, added in reasonable density factors, and then addressed the individual characteristics of the AQUATIC VENUES to include splashing at the surface and the temperature of the water.

To calculate the minimum cfm of fresh air required:

Minimum number of cfm of fresh air for AQUATIC FACILITY by type =

(R_a X AQUATIC VENUE and DECK area in ft^2) + (AQUATIC VENUE A area in ft^2 X (R_p / Density factor)) + (AQUATIC VENUE B area in ft^2 X (R_p /Density)) + *(DECK area in ft^2 X (R_p/Density factor)) + (R_a X Spectator area in ft^2) + (Spectator area in ft^2 X (R_p/Density factor))*

Example 1: Aquatic Facility with Flat Water Feature

Aquatic Venue	Area (ft^2)	Fresh Air Required (cfm)
Deck Minimum	30,000	14,400
Water=Flat	15,000	7,500
Water=Agitated	0	0
Water=Hot	0	0
Deck Area Only	15,000	3,000
	Feature Area Subtotal	24,900
	Total cfm / ft^2 feature / deck area	**0.83**

Aquatic Venue	Area (ft^2)	Fresh Air Required (cfm)
Spectator Area minimum	6,500	390
Spectator additional	6,500	7,386
	Total cfm	32,676
	Total cfm / ft^2 w/ spectator area	**0.90**

Example 2: Aquatic Facility with Agitated and Hot Water Venues

Aquatic Venue	Area (ft^2)	Fresh Air Required (cfm)
Deck Area	60,000	28,800
Water=Flat	0	0
Water=Agitated	25,000	41,667
Water=Hot	2,000	12,000
Deck Area Only	33,000	6,600
	Feature Area Subtotal	89,067
	Total cfm / ft^2 feature / deck area	**1.48**

Aquatic Venue	Area (ft^2)	Fresh Air Required (cfm)
Spectator area minimum	2,500	150
Spectator area additional	2,500	2,841
	Total cfm	92,058
	Total cfm / ft^2 w/ spectator area	**1.47**

Appendix 3: Dye Test Procedure

Dye testing should be performed to determine and adjust the performance of the RECIRCULATION SYSTEM. Dye studies tend to be qualitative in nature.[384]

Some judgment is generally required to determine whether a dye study should be classified as passing or a failing. In general, dead zones (or areas of poor circulation) would indicate a failure that could be fixed by adjusting the INLETS or other system hydraulics. If the POOL does not reach a uniform color within 15 minutes, then adjustments are required.

Materials

- Crystal violet *($C_{25}N_3H_{30}Cl$)(20 g/ 50,000 gal)*
- Sodium thiosulfate penta-hydrate *($Na_2S_2O_3$. $5H_20$) (1.2 oz/ 1 ppm free CHLORINE/ 10,000 gal)*
- Sodium hypochlorite *(Bleach 5.7% AVAILABLE CHLORINE) (6.64 L/ 50,000 gal)*
- Two containers *(20 L or 5 gal)*
- Video camera
- Photo camera *(optional)*
- Tripod
- CHLORINE detection kit
- Pump *(capable of 700 mL/min or 0.18 GPM)*
- Tubing *(~6.4 mm or 1/4-inch ID)*
- Tubing clamps
- Fittings, adapters, and Teflon tape *(for threaded connections)*
- Scale
- Gloves
- Timer

Procedure

1) Use a scale to weigh out the correct amount of crystal violet needed. Be sure to wear proper SAFETY equipment when handling any chemicals.
2) Make the stock crystal violet solution by mixing the crystal violet and 3 gallons of non-chlorinated water in a container.
3) If you do not plan to use the POOLS existing DISINFECTION system during the dye removal process, then it will be necessary to prepare a sodium hypochlorite solution. To do this follow the recommended dose of 6.64 liters of bleach *(5.7% AVAILABLE CHLORINE)* per 50,000 gallons of POOL water. Place the correct amount into a separate container.
4) Two days prior to the dye study, cut off the POOL's DISINFECTION system, and then measure the CHLORINE concentration of the POOL. On the same day as the DISINFECTION system is turned off, weigh out enough sodium thiosulfate penta-hydrate to neutralize the CHLORINE that is present and dump it around the perimeter of the POOL. It is necessary to neutralize the CHLORINE because it will react with the dye. Come back the following day to make sure there is no CHLORINE, and likewise on the day of the dye study.
5) Prepare the pump by attaching the tubing to the existing piping and calibrate the flow rate to 700 mL/min. At this flow rate, the stock solution of dye will be injected into the POOL over a 16-minute period. Tube clamps may be used to secure the connection between the tubing and the connectors.
6) Prepare the filter room by laying down a trash bag *(or similar item)* as protection from a potential chemical spill/leak. Then place the pump and containers containing the dye stock solution and sodium hypochlorite solution on the plastic cover.
7) Prepare a location in the pipe network *(preferably after the filter)* to inject the chemicals. If a location does not already exist *(e.g., an existing CHLORINE feed or acid feed point)* then one will need to be made by tapping the pipe and inserting the proper fitting.
8) Attach the tubing from the pump to the existing or newly created injection point. Depending on what fitting is present you might need an adapter for the tubing. The other end of the tubing should be placed in the chemical container holding the dye.

9) Make sure all assistants are in place to record video, take pictures, collect data, and time injection to 15-minute pass/fail observation point.
10) When ready to start, turn on the pump. The dye should begin to flow into the POOL. Start the timer at the same time as the pump is turned on *(pump on, time (t) = 0 min)*. The stock dye solution should be depleted in 16 minutes. After 16 minutes, turn the pump off so that air will not be introduced into the system.
11) Record the time when the dye is first observed coming into the POOL.
12) Record the time when the POOL water is completely dyed *(having uniform color)*.
    a. Most POOLS should be uniformly dyed within 15-20 minutes (and generally no more than 30 minutes) when the RECIRCULATION SYSTEM is hydraulically balanced.
13) Record any observations or patterns, including dead spots or short circuiting, and the corresponding times that they were noticed throughout the test.
    a. Adjustments should be made to the RECIRCULATION SYSTEM to correct for any problems observed. Adjustments could include the following:
        i. the direction of INLETS (up and down as well as left and right),
        ii. the velocity of water through the INLETS (when adjustable by INLET modification or TURNOVER TIME adjustment), and
        iii. the proportion of water from the surface overflow and main drain components of the RECIRCULATION SYSTEM.
14) Remove the dye by re-chlorinating the POOL. Switch the tubing from the container of dye to the one containing the sodium hypochlorite and turn the pump back on. Another option would be to restart the POOL's current DISINFECTION system.
15) Observe and record what you see as the dye is removed from the POOL through chlorination.

MAHC References

A Note about References:

The resources used in all MAHC modules come from peer-reviewed journals and government publications. No company-endorsed publications have been permitted to be used as a basis for writing code or annex materials.

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