2018 Annex to the Model Aquatic Health Code

Scientific Rationale

Mini-MAHC: Preventing Pool Chemical Injuries






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

Extracted from the 2018 MAHC

CS295591-A

Mini-MAHC - Annex

Preventing Pool Chemical Injuries

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

1. Code Language (3rd Edition, 2018)
2. Annex - Rationale (3rd Edition, 2018)

Purpose:

Specific public health issues addressed in the MAHC are often spread across multiple chapters. Mini-MAHCs make the MAHC more accessible by summarizing the code and annex language addressing a specific public health issue into a single, concise document. Environmental health practitioners and pool operators can use Mini-MAHCs to quickly find relevant MAHC guidelines and rationale to promote health and safety for patrons and staff and references content from the 2018 MAHC Code Language and Annex (3rd Edition). For MAHC language on preventing in-line production of toxic chlorine gas go to the Preventing In-line Production of Toxic Chlorine Gas Mini-MAHC.

This Mini-MAHC Annex supports guidance focusing on preventing pool chemical injuries caused by chemical spills, leaks, or operator error during handling of pool chemicals. Environmental health practitioners and pool operators will find code on:

- Safe equipment room and chemical storage area design and construction since some pools combine areas.
- Pool chemical safety training for aquatics staff that promotes the proper use of personal protective equipment (PPE).
- Safe chemical storage and handling.
- Chemical spill procedures and emergency response.

The Mini-MAHC Annex references content from the 2018 MAHC Code Language and Annex (3rd Edition).

IMPORTANT

Unless otherwise noted,

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

Citations were removed to condense the Mini-MAHCs. A list of references are in the complete version of the 2018 MAHC Annex (3rd Edition).

4.0 Aquatic Facility Design Standards and Construction

4.2 Materials

4.2.2.3 Mechanical Systems

4.2.2.3.3 Indoor Aquatic Facility Air Pressure

Air-pressure-supported INDOOR AQUATIC FACILITIES may require pressurization of adjoining or connected spaces.

4.6 Indoor / Outdoor Environment

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 1st edition of the MAHC. The MAHC found that:

- Most addressed only moisture control;
- The terms used were sometimes vague with 11 of the 28 CODES having very general language typically stating "adequate" or "proper" ventilation without clear definitions of these terms;
- Only three CODES and NEHA specify compliance with ASHRAE STANDARDS;
- Most refer to their state and/or local ventilation and/or mechanical CODE for compliance requirements;
- Only five 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 industry has always had a challenge with indoor air quality. With the relatively recent increases in building large indoor waterparks, which have high BATHER COUNTS and contamination burdens and exposure times unseen before, indoor air quality is an increasingly important health concern. The media focus in recent years has highlighted this challenge. Although the AIR HANDLING SYSTEMS of these AQUATIC FACILITIES are quite sophisticated, there are many variables to consider. 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. 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.

4.7.3 Disinfection and pH Control

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 it can result in a high concentration of acid and CHLORINE being mixed 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. 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.

4.7.3.2.7 Feeders for pH Adjustment

It is recommended that the solution's reservoir supply be sized to hold a minimum of 1 week's supply.

5.7.3.5 Feed Equipment

The Chlorine Institute has checklists and guidance for working with compressed CHLORINE gas at: http://chlorineinstitute.org/stewardship/ci-checklists.cfm.

4.9 Filter/Equipment Room

4.9.1 Equipment Room

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.

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 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 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 CODE, whichever are greater.

- See IMC Section 304.1.
- See NFPA 54 Sec. 8.1.2.

Increased Ventilation

Rooms containing combustion equipment may 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 should be so constructed as to allow for the planned equipment, or should be modified as necessary. Where an EQUIPMENT ROOM contains combustion equipment which uses equipment-room 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 of them 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 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 contains combustion equipment which uses EQUIPMENT ROOM 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 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 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, and/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, and/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 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 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, and/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 and an INDOOR AQUATIC FACILITY, the floor of the EQUIPMENT ROOM should slope 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. 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, which will prevent spills from reaching the INDOOR AQUATIC FACILITY floor.

Note: Equipment-room 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, there is a very good chance that other fluids may 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 so as 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, 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, 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 associated injuries have been routinely documented. 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 4,876 *(95% confidence interval [CI]: 2,821–6,930)* emergency department *(ED)* visits attributable to POOL chemical--associated injuries occurred in 2012; the most frequent diagnosis was poisoning *(2,167 ED visits [95% CI: 1,219–3,116])*. CDC has developed recommendations to reduce the risk of chemical-associated injuries at AQUATIC FACILITIES. 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 local building CODES and/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 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. Recommendations for Preventing Pool Chemical-Associated Injuries accessed at http://www.cdc.gov/healthywater/swimming/pools/preventing-pool-chemical-injuries.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.

4.9.2.1.4.1 AHJ Requirements

The intent is to allow some flexibility since installation in the CHEMICAL STORAGE SPACE may be prone to failure due to corrosion. External eye wash stations should be close and easily found such as in a location outside the door that all staff must walk past. The MAHC will continue to look for data supporting a maximum distance from the door.

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 Fencing

Such part of an outdoor space as does not join a wall of a building should be completely enclosed by fencing that is at least 6 feet *(1.8 m)* high on all other sides.

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 may 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 m)* 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 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
  - o 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 not be limited to, the locks on hotel-room doors, the lock on the door of a personnel-file STORAGE room, 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 to 0.15 inches *(1.3 to 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 I.W.C. to 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 may 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, 2011, 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: I*dentifying 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 may react on exposure to sunlight.

4.12.10 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 may 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 may 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. Recently, the National Collaborating Centre for Environmental Health (NCCEH) produced two documents related to potential environmental health risks of floating 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.

4.12.10.1 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. 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.

4.12.10.8 Disinfection

The CMAHC Ad Hoc Committee considered several factors that distinguish FLOATATION TANKS from other forms of recreational water when determining the minimum requirements for DISINFECTION. One key factor in disease transmission risk is that the potential routes of exposure are different than typical swimming POOLS. The following information is excerpted. "There are several aspects of FLOATATION TANKS and their typical user profile that may modify the risk of communicable disease compared to POOLS and 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 significantly 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 BY-PRODUCT 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 decrease the likelihood of ingestion and eye contact as routes of transmission compared to recreational water facilities. FLOATATION TANK users do remain potentially vulnerable to skin, genitourinary, and outer ear infections. Inhalation may represent another route of transmission, as some FLOATATION TANK models agitate the water vigorously between clients; it is unclear if this may 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, may 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 disease transmission between clients in float facilities."

Potential pathogens of concern, their ability to survive and/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. 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 and/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. The most thorough evaluation of a FLOATATION TANK was carried out by NSF as part of the certification of an O_3 / UV system according to CCS-12804, which met the DISINFECTION efficacy criteria. 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, its use as a DISINFECTANT at the levels 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;
- 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 may 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 and/or slime through routine physical scrubbing and/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. 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) could be expected to permeate all parts of the tank and plumbing.

Upon additional discussion, 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.

4.12.10.9 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 BY-PRODUCTS. However, there is insufficient information at this time to determine if, or to what extent, there may be a problem.

5.0 Aquatic Facility Operation and Maintenance

5.6 Indoor / Outdoor Environment

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 level to DISINFECT properly, but high residual levels 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 levels of CHLORINE/bromine in the POOL results in lower levels of DBPs in the presence of organic and inorganic CONTAMINANTS.
- High residual levels 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 levels could likely be maintained at a lower level due to the absence of dechlorination due to sunlight.
- Lower pH levels increase the effectiveness of CHLORINE and by maintaining pH less than 7.5, less CHLORINE is required to achieve effective DISINFECTION.

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 and/or the AIR HANDLING SYSTEM equipment manufacturer's recommendations.

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.

5.7.3 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.

5.7.3.1.2 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 levels ranging from 1-8 ppm *(mg/L)*, depending on the product. The efficacy of these products have 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.

5.7.3.1.4 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 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, and 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 the general public.
- ***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. In a comparison study of common DISINFECTANT methods, Lee et al. found salt brine electrolysis formed the highest levels of bromodichloro-methane, dibromochloro-methane and bromoform. 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. 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 FACILITIES include SECONDARY DISINFECTION SYSTEMS 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 DISINFECTION SYSTEMS are utilized. SECONDARY DISINFECTION SYSTEMS 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 DISINFECTION SYSTEM 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 DISINFECTION SYSTEMS will be enhanced when the shortest TURNOVER TIMES are achieved for any particular type of AQUATIC FACILITY. The use of certain types of AQUATIC VENUES presents an increased risk of RWI transmission to users. These AQUATIC VENUES include THERAPY POOLS, WADING POOLS, SPRAY PADS, swim schools, INTERACTIVE WATER PLAY AQUATIC VENUES, and AQUATIC FEATURES. Given that users of these types of facilities frequently have naive immune systems *(e.g., children less than 5 years of age)*, 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. 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* and/or *Cryptosporidium parvum* infections after playing at an "interactive" water fountain at a beachside park in Florida. 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 was passed, which required the installation of SECONDARY DISINFECTION *(e.g., UV radiation or ozonation)* on water returning through the spray features.

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 levels must continue to be provided. The manufacturer's recommended procedures should be followed to avoid the potential of staining, and operating the POOL with copper levels outside the recommended range may cause staining. Copper-based algaecides should not be used in these systems since use of these products increase the level of copper in the POOL 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.

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 between 30 and 50 ppm *(mg/L)* as product *(6 to 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 DISINFECTION SYSTEMS require the use of a halogen as the primary DISINFECTANT, the use of PHMB, even with a secondary system is problematic. PHMB **IS NOT** compatible with CHLORINE or bromine. POOLS using PHMB have a serious treatment dilemma for control of *Cryptosporidium* after a suspected outbreak or even a diarrheal fecal accident. 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 on-line.

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 (http://ppis.ceris.purdue.edu/#.) Product claims for uses and concentration may 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 to 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 and 150 ppm *(mg/L)* in simulated POOL conditions. 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 (http://ppis.ceris.purdue.edu/#). Product claims for uses and concentration may 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. 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

During the drafting of this section of the MAHC, several members of the MAHC had interest in using 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 may be a very rapid remedial treatment for these life-threatening pathogens. If the EPA registration status of chlorine dioxide changes, the MAHC suggests that 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 health club SPA where other treatments were proven to be ineffective. More information on emergency exemptions can be found on the EPA website at http://www.epa.gov/opprd001/section18/. 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

POOLS and SPAS may 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 may 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. Pesticides and Pest Control Operations. Products registered in California but sold outside of the state usually, but are not required to, have the California registration number on the label. Any local agency 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:

- Efficacy of the CHLORINE,
- BATHER comfort, and
- Maintenance of balanced water.

Each of these reasons are discussed briefly below:

Efficacy of Chlorine

The efficacy of CHLORINE/HOCl is dramatically impacted by pH and therefore pathogen inactivation can be severely affected by higher pH levels where only a small percentage of FREE CHLORINE is active. Lower pH levels below this range allow a greater percentage of FREE CHLORINE to be "active". Further data are needed to ensure that lower levels *(e.g., 6.8 to 7.2)* do not adversely impact membranes, particularly eyes. The present practice of maintaining the pH between 7.2 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. The best general authority is the 1972 edition of the Handbook of Chlorination by Geo. Clifford White. The 1972 edition of this widely recognized authority on CHLORINE chemistry is the only edition that has a chapter especially on POOLS. Much, but not all, of the POOL chemistry chapter can be found in subsequent editions. Copies of the 1972 edition are difficult to locate in libraries but are available for sale on the internet as of July 2009. The discussion on efficacy and BATHER comfort is a summary of the 1972 edition discussion on pH. 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 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. Thus from a public health perspective, it is desirable to maintain the pH so as to maximize the portion of HOCl portion of the FREE CHLORINE present in the water.

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. Studies on the sensitivity of BATHERS' eyes to pH changes in the water show wide variations in tolerance limits. The tolerance of the eye to shifts in pH is also impacted by the concentration of FREE CHLORINE, combined CHLORINE, and alkalinity. Under normal POOL conditions, the optimum limits for BATHER comfort appears to be from pH 7.5 to 8.0.

Potential for Lowering pH in the Future

During the review of the data, the MAHC had a broad interest in lowering the minimum pH. This would increase the efficacy of the CHLORINE by increasing the proportion of HOCl *(at the expense of hypochlorite)* and thus increase DISINFECTION efficacy. This was not recommended because of the lack of data on the impact on BATHERS, particularly the eyes. If additional information on the impact of lower pH on BATHERS' skin and eyes is developed, the MAHC suggests that the acceptable range for pH be reexamined. As part of the reexamination, consideration should also be made concerning how this change will impact the water balance and any possible negative impact on the facility. In addition, many manufacturers include a pH range on equipment use so that lowering the pH may void the warranty.

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.

5.9.1 Chemical Storage

5.9.1.1 Local 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 from 0 to 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. An important component of product stewardship and workplace SAFETY, it is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and 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. The SDS is also required to be made available to local fire departments and local and state 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 Recommendations for Preventing Pool Chemical-Associated Injuries" at: http://www.cdc.gov/healthywater/swimming/pools/preventing-pool-chemical-injuries.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 levels 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)*.

6.0 Policies and Management

6.0.1 Staff Training

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 and/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 may 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. All 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 DISINFECTANT [throat irritation; nasal dryness or irritation; shortness of breath; cough; eye irritation; nausea; headache; drowsiness; chest pain], or any other chemicals used for DISINFECTION.

6.1 Qualified Operator Training

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 handling of erosion feeders/chemical mixing. See MAHC Annex 4.9.2 for discussion on 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 DISINFECTION SYSTEMS*– 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 may also 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 food-grade cellulose.
- *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 have an understanding of 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 may 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

6.1.2.1.4.6 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-associated health events 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-related events showed 71.9% of the events involved human error. NEISS and the NPDS data indicate that POOL chemical exposures and associated injuries are common. Data from NEISS show that inhalation of chemical fumes and splashing POOL chemicals into the eyes or onto the skin were the primary POOL chemical-associated 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–associated health events reported in New York State. Although no one data source alone clarifies completely the epidemiology of POOL chemical--associated injuries, together they reveal multiple commonalities that suggest these injuries are preventable. CDC recommendations for preventing injuries associated with POOL chemicals were based on a review of the New York State health events and other government regulatory guidance. These recommendations focus on improving facility design, engineering, education, and training that stresses safe chemical handling and STORAGE practices and safe and preventive maintenance of equipment.

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.

6.3 Facility Staffing

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. The MAHC agreed 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 or not QUALIFIED LIFEGUARDS are present. *Note that the 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. The MAHC agreed that 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 and/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 may be conducting periodic reviews and may 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 may 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 may 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 may be a danger to BATHERS and to themselves. Serious deficiencies that are not immediately corrected may 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.

6.3.3.2 Emergency Action Plan

The MAHC agreed that 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 POOLS or other areas of the AQUATIC FACILITY should those hazards be present. In particular, fecal incidents, water clarity, and inclement weather may 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 FACILITY.

6.3.3.3 Pre-Service Requirements

6.3.3.3.1 Safety Team EAP Training

The MAHC agreed that 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 may require more specific skills and physical abilities, which once learned, must be maintained as emergencies can occur at any time. This demonstration of skill and/or knowledge verifies the staff person is ready to fulfill their role.

6.3.4 Staff Management

6.3.4.5 Emergency Response and Communications Plans

6.3.4.5.1 Emergency Response and Communication Plan

CHEMICAL STORAGE and EAP/evacuation info also must be filed with local fire/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 operation is unique. Some operations may 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/sites/production/files/2015-03/documents/list_of_lists.pdf

6.4 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, in particular gastroenteritis. Another report identified the most frequently reported type of RWI outbreak as gastroenteritis, the incidence of which is increasing. Prevention of RWIs at treated venues requires POOL operators to:

- Maintain appropriate DISINFECTANT concentration and pH to maximize DISINFECTANT effectiveness, and
- Ensure optimal water circulation and filtration.

A study of POOL inspection data underscored the need for improved maintenance. A total of 4,873 *(11.6%)* of 42,161 inspections identified serious violations that threatened the public's health and resulted in immediate POOL closure. Of 40,585 inspections, 3,549 *(8.7%)* identified DISINFECTANT concentration violations; of 38,247 inspections, 4,506 *(11.8%)* identified pH violations. Automated chemical feeder violations were documented during 2,260 *(6.3%)* of 36,137 inspections. Only one (6%) of 16 included data on AQUATIC FACILITY setting; almost all POOL (99.5% [55,622/55,913]) and hot tub/SPA (99.1% [20,259/20,449]) inspection records were missing data on AQUATIC FACILITY setting. Use of the setting algorithm increased the number of inspection records with setting data; however, after the setting algorithm was run, 75.6% (42,249/55,913) of POOL and 84.2% (17,213/20,449) of hot tub/SPA inspection records still were missing AQUATIC FACILITY setting data, thus no analyses stratified by setting were conducted. 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 federal, state, and local partners from different disciplines is needed. This collaboration should include environmental health practitioners with technical knowledge about the operation and maintenance 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-Related Injuries) for further discussion and background. The information identified in these reports, along with existing recreational water injury data and first hand inspector experience, drove the development of the critical risk factors for recreational water injury and illness at treated AQUATIC VENUES. The eight broad critical risk factors for recreational water illness and injury are:

- Management; supervision; training; operation;
- Lifeguard services;
- DISINFECTANT residual;
- pH *(low or hi)*;
- Water clarity;
- Facility ENCLOSURE / entry protection;
- Entrapment protection; and
- 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. 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. 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 (recommended pH range 7.2–7.8) 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 FEATURE 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; and
- 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);* and
- 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 DISINFECTION SYSTEM 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; and
- 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; and
- 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.); and*
- 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, and
- 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; and
- Financial report including monthly and annual summaries, projections and trends.

6.6 AHJ Inspections

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 POOL must be closed until the violations are corrected. Whenever a POOL 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 POOL. The factors being considered IMMINENT HEALTH HAZARDS cover known risk areas:

- Low or absent DISINFECTANT levels lead to reduced inactivation of pathogens and these conditions have been associated with infectious disease outbreaks.
- 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. 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.
- 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.