

Model Aquatic Health Code

Preface / User Guide / Glossary Module CODE Sections Public Comment and Responses After the First 60-day Review

NOT Currently Open for Public Comment

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

This information is distributed solely for the purpose of pre dissemination public comment under applicable information quality guidelines. It has not been formally disseminated by the Centers for Disease Control and Prevention. It does not represent and should not be construed to represent any agency determination or policy.

These modules have been reorganized to separate CODE and ANNEX sections

1. IAAPA, Alexandria, Virginia

Comment:

a) Re: Section 3.0, Definitions, regarding “Aquatic Venue”: This definition specifically includes “fountains,” meaning the Scope could be stretched to include for a fountain that is designed and purposed solely for decorative purposes. In order to avoid any confusion, exclusionary language should be provided for decorative fountains.

Changes to module/annex:

The MAHC has modified language to put “interactive” in front of the language. We think it inadvisable to put exclusionary language in the MAHC related to fountains versus letting plan review specialists determine the likelihood of exposure. Many outbreaks have occurred from interactive fountains, which in many circumstances were initially called decorative fountains and were not “intended” for human interaction. The MAHC will focus on the reality of likely human exposure since “intent” may not be enough to prevent human use and exposure.

Comment:

b) Re: Section 3.0, Definitions, regarding “High Risk”: The term “risk” is not recommended in this application, indicating that some level of risk may be acceptable. Suggest deleting this definition, or at least coming up with a term other than “risk.”

Changes to module/annex:

We think that based on prevalence of disease, users, and outbreak investigations that different aquatic venues can and should be differentiated into relative risk groups. Based on the inherent “communal bathing” nature of swimming, all swimming has risk of injury and infectious disease transmission associated with the activity whether in a treated environment (pools) or natural environment (lakes/rivers/oceans). These higher risk venues (e.g., those intended for diaper-aged children) have a higher risk of contamination since diaper-aged children are incontinent and have higher rates of diarrheal illness than other age groups. However, the use of “high” has been changed to “increased” since “high” may be misinterpreted to mean we know the risk versus that the term is being used in a relational manner comparing between aquatic venues. This risk categorization is used in the MAHC to categorize which aquatic venues will require additional water treatment due to the increased potential for contamination.

Comment:

c) Re: Section 3.0, Definitions, regarding “Pool”: Replace the word “impounded / standing” with “captured.”

Changes to module/annex:

Changed as suggested

Comment:

d) Re: Section 3.0, Definitions, regarding “Water Feature”: This is a fairly broad definition that includes for pools. If it was not intended to be so broad, perhaps some examples would make it clearer.

Changes to module/annex:

The definition is now under aquatic feature and has been reworded with examples as suggested.

2. Richard Falk, pool owner.

Comment:

a) Re: Section 1.7.2.1: “Given the purpose of the document as discussed in item 1.2 of this Preface, the Agency will be especially interested in addressing problems identified by those in government and industry who are responsible for implementing the MAHC.” Though the government, specifically the CDC, has a mission with a concern for public health, parts of the industry (specifically, corporations) have primarily a fiduciary responsibility to their shareholders to maximize profit and do not necessarily have incentive to maximize public safety or health. Since it is the swimming public who are most affected by the quality of this standard in terms of it being unbiased by profit motives, I believe it is important for the Agency to consider scientifically-sound input from **any** source, including the public, as being at least as valuable as potentially biased input from profit-motivated parts of industry. After all, it is the swimming public that bears the greatest impact from WBDOs.

Suggested wording change: Delete the quoted sentence shown in the comments area above for Section 1.7.2.1 and the word “also” from the subsequent sentence.

Changes to module/annex:

We agree and the intent was not to intimate that the public could not give input. Section 1.8.2 of the ANNEX makes this clearer

Comment:

b) Re: 3.2.1.1.2, Breakpoint Chlorination: 3.2.1.1.2 Breakpoint Chlorination: “The amount of free chlorine that must be added to the water to achieve breakpoint chlorination is approximately ten times the amount of combined chlorine in the water.”

The above statement is not true. The rough 10x rule is only true for oxidation of ammonia (not CC or monochloramine) with chlorine when the amounts of chlorine and ammonia are each measured in their respective ppm basis, specifically with chlorine measured as ppm Cl₂ (chlorine gas) and ammonia measured as ppm N (atomic nitrogen). The 10x rule is not true when determining the Free Chlorine (FC) needed to oxidize already formed Combined Chlorine (CC) for two reasons. First, 2/3rds of the required FC has already been used in the formation of CC. Second, CC is measured in the same units as FC, namely as ppm Cl₂ (chlorine gas) so the proper ratio is far less and is stoichiometrically only 0.5 in ppm Cl₂ units if there were no side reactions (in practice, it’s probably between 0.6 and 0.7 ppm, so a rule using 1 is reasonable).

The entire description in 3.2.1.1.2 is also misleading in terms of what goes on in pools since breakpoint chlorination from slowly introduced ammonia into chlorinated water occurs on a more continual basis. The traditional breakpoint chlorination graphs only apply to additions of chlorine to water already containing ammonia since breakpoint chlorination was observed in drinking water treatment. Breakpoint chlorination could also apply to instantaneous introductions of ammonia into chlorinated water where the amounts of chlorine and ammonia on a molar basis are roughly comparable so would apply more to a urinary release than to smaller amounts of sweat. Also, the largest component of sweat and urine is urea, not ammonia, (see table 4.1 on document page 62, PDF page 85, in http://www.who.int/entity/water_sanitation_health/bathing/srwe2full.pdf) and the details of the oxidation of urea by chlorine are not definitively understood (though some reactions have been proposed).

It's not that the chemistry doesn't apply, but rather that the oxidation of ammonia can occur quickly enough under normal conditions to not register significant CC where small amounts of ammonia are added to much larger concentrations of chlorine and therefore not see the traditional breakpoint curve. CC can be measured under conditions of high bather load or when there is a large introduction of ammonia such as from a urinary discharge (i.e. peeing in the pool).

Suggested wording change: Either delete the incorrect sentence or change it to "The amount of free chlorine (measured as ppm Cl₂) that must be added to the water to achieve breakpoint chlorination is approximately ten times the amount of ammonia (measured as ppm N) in the water." If you keep this modified sentence, then you might add, "The amount of free chlorine needed to achieve breakpoint of combined chlorine is roughly equal to the amount of combined chlorine in the water." It's probably best to just leave the 10x rule out completely. In fact, I'm not sure if you will even need the definition of "breakpoint chlorination" in the standard at all. This is not drinking water treatment so it will be uncommon to have water with ammonia explicitly measured with an ammonia test kit (though this does become useful when CYA is degraded by bacteria over a winter when a pool is "let go" and the resulting ammonia needs to be oxidized by chlorine – see http://umbbd.msi.umn.edu/cya/cya_map.html for the degradation pathway).

Changes to module/annex:

Under consideration. The term is not referred to in these modules

Comment:

c) 3.2.1.1.2 Free Chlorine Residual: "means the available disinfectant in the water. It is the portion of total chlorine that is not combined chlorine and is available as disinfectant. When chlorine is added to water, hypochlorous acid is produced in either the molecular state (HOCl) or the ionized state (hypochlorite ion (OCl⁻) plus hydrogen ion (H⁺)), and a by-product specific to the type of chlorine is produced. The pH of the water determines the amount of hypochlorous acid in each state. HOCl is a very effective bactericide and is the active available chlorine disinfectant in the water. OCl⁻ is also a bactericide, but

acts more slowly than HOCl. Thus chlorine is a much less effective bactericide at high pH. The sum of HOCl and OCl⁻ is referred to as “free chlorine” in pool water. The hypochlorous acid that remains in pool water uncombined with ammonia is called “free chlorine residual”. A free chlorine residual must be maintained for adequate disinfection.”

There are so many things wrong with this that I will go through each problem separately, but all of the issues relate to ignoring what happens when Cyanuric Acid (CYA) is present in the water, either from already being in the water (e.g. from pure CYA or previous use of stabilized chlorine) or from being added by a stabilized chlorine source (e.g. Trichlor or Dichlor).

When chlorine is added to water, the end result cannot be predicted by only knowing the type of chlorine that is added, but rather is fully determined by what the resulting values are for Free Chlorine (FC), pH, Cyanuric Acid (CYA) and temperature. In water containing Cyanuric Acid (CYA), the vast majority of the chlorine is in the form of chlorinated cyanurates (essentially, chemical species with one or more chlorine bound to a CYA core). Specifically, at a temperature of 77F, a pH of 7.5, an FC of 3.0 and a CYA of 30 ppm, 97% of the chlorine is in the form of chlorinated cyanurates, 1.5% is hypochlorite ion (OCl⁻) and 1.5% is hypochlorous acid (HOCl). There is an equilibrium between the chlorinated cyanurates and hypochlorous acid and has been known in great detail since 1974.

The concentration dependence of hypochlorous acid on pH is not nearly as strong when Cyanuric Acid (CYA) is present. With no CYA in the water, going from a pH of 7.5 to a pH of 8.0 drops the hypochlorous acid concentration by a little over 50%. With 30 ppm CYA in the water and 3.0 ppm FC (and 77F temp), this same pH change results in a drop of hypochlorous acid concentration by only around 15%. CYA, via the chlorinated cyanurates, acts as a hypochlorous acid buffer, resisting changes in its concentration with changes in pH (as a consequence, the hypochlorite ion concentration changes even more with pH). Of course, this difference in pH dependence is somewhat of a moot point since the hypochlorous acid concentration is so much higher when CYA is not present. Unless the FC is very low (which is hard to maintain consistently), a drop of 50% is not so dramatic. In the examples I gave, the hypochlorous acid concentration with no CYA drops from 1.453 ppm to 0.687 ppm while with 30 ppm CYA it drops from 0.042 ppm to 0.036 ppm. With no CYA in the water, the FC would have to be only 0.16 ppm at a pH of 8.0 to get to 0.036 ppm.

OCl⁻ is a far weaker bactericide than HOCl, by a factor of around 20 (for E. coli ATCC 11299) so simply saying that it acts more slowly than HOCl is an understatement (see <http://www.ehponline.org/members/1982/046/46002.PDF>). For most practical purposes, neither OCl⁻ nor the chlorinated cyanurates are effective bactericides when compared to HOCl, even when accounting for the greater concentration of the chlorinated cyanurates.

The Free Chlorine (FC) test measures not only the HOCl and OCl⁻ concentrations, but also that of the chlorinated cyanurates because chlorine is released quickly from them in the time of the test (i.e. in seconds). The hydrolysis half-life of 4.08 seconds for HCICY⁻ and 0.25 seconds for ClCY₂⁻ may be found here: D. Matte, B. Solastiouk, A. Merlin and X. Deglise, "Etude Cinetique de la N-Chloration de l'Acide Cyanurique en Phase Aqueuse (Kinetic Study of N-Chlorination of Cyanuric Acid in the Aqueous Phase)", Can. J. Chem., 1990, 68, 307-313. as well as in the table on page 12 (PDF page 18) in this link (note that the table has some errors in the equilibrium constants relative to the O'Brien paper because some constants were taken from another source, Brady, according to Thomas Kuechler of Oxy Chemical): <http://www.epa.gov/HPV/pubs/summaries/tricltrz/c14659rr.pdf>

Though the dominant chlorinated cyanurate species is HCICY⁻, deprotonation reactions are extraordinarily fast so conversion to ClCY₂⁻ is extremely fast so in practice the net half-life of the chlorinated cyanurates when hypochlorous acid gets depleted (such as during the FC test) is 0.25 seconds.

I am confused what the Free Chlorine Residual really is in your definition. Is it simply the concentration of hypochlorous acid alone? Or is it the Free Chlorine (FC) as measured in the FC chlorine test? What is confusing is the qualifier of "hypochlorous acid that remains in the pool water uncombined with ammonia". Did you mean "chlorine that remains..."? Hypochlorous acid, by definition is not combined with ammonia – when it is, it is called monochloramine (or dichloramine, etc.).

Suggested wording change: "Free Chlorine Residual" means the available reservoir of chlorine in the water. It is the portion of total chlorine that is not combined chlorine, is measured as Free Chlorine (FC) in standardized tests and is the chlorine capacity that can be quickly converted to become a disinfectant. It is the sum of hypochlorous acid (HOCl), hypochlorite ion (OCl⁻) and various species of chlorine bound to Cyanuric Acid (CYA), if present. The CYA level, pH and temperature of the water determines the amount of hypochlorous acid. HOCl is a very effective bactericide and is the active available chlorine disinfectant in the water. OCl⁻ is also a bactericide, but acts much more slowly than HOCl. The chlorine bound to CYA might be a bactericide, but if it is, it acts much more slowly than HOCl. Because the amount of HOCl is dependent on pH (though is less dependent when CYA is present), chlorine is a less effective bactericide at high pH. A free chlorine residual must be maintained for adequate disinfection.

Changes to module/annex:

Altered after reading suggestion. We do not feel it needs the detail specifying chlorinated cyanurates to define the term.

Comment:

d) 3.2.1.1.2 Oxidation: "... which allows the contaminant to be more readily removed from the water. It is the "chemical cleaning" of pool water. Oxidation can be achieved by common disinfectants (e.g. chlorine, bromine, ozone, potassium monopersulfate).

Though the above statement is true for some compounds such as ammonia and possibly urea, it is not true for other compounds. For many organics, they will not be fully oxidized to nitrogen gas, carbon dioxide, and water. Instead, they may be broken up into smaller chemical species and/or become more polar and therefore stay dissolved more readily in water.

Potassium monopersulfate is not a disinfectant (at least not strong enough to be called such according to DIS/TSS-12) , but rather an oxidizer.

Suggested wording change: Oxidation: "... which allows the contaminant to be either more readily removed from the water or to become more soluble in the water. It is the "chemical cleaning" of pool water. Oxidation can be achieved by common disinfectants (e.g. chlorine, bromine, ozone) or by oxidizers (e.g. potassium monopersulfate).

Changes to module/annex:

Under consideration. The term is not referred to in these modules