# SECTION 5 – WATER QUALITY AND TESTING

Maintaining water quality is a fundamental role in operating an aquatic facility.

The objectives of an operator should be to:

- Ensure the water is properly disinfected at all times, to prevent transmission of infectious diseases,
- Achieve maximum patron comfort, and
- Maximise longevity of the facility structure.

Whenever an aquatic facility is available for use, the water needs to contain an adequate level of a chemical that can destroy micro-organisms. By far the most common chemical used for disinfection is chlorine. This material has the advantages of being a relatively low cost, highly effective disinfectant that is readily available.

However, chlorine is also a highly reactive chemical, which non-selectively combines with nitrogen-rich pollutants in the water, to produce unwanted chemicals known as chloramines. These give the water a characteristic pungent chlorine-like smell, and irritate the eyes and skin of patrons.

Chloramines are also known to be less effective disinfectants than free chlorine. High concentrations of chloramines reduce the overall effectiveness of the chlorination process.

The chloramine problem is generally worse in heavily patronised facilities, where patrons add large amounts of urea and other nitrogen-rich bodily wastes to the water.

A number of technologies are now available to reduce the levels of chloramines in water. Examples include the use of ozone gas, ultraviolet light irradiation, and the addition of non-chlorine oxidising chemicals to the water. The use of these technologies should be considered for indoor aquatic facilities with significant bather numbers.

Chlorine also undergoes significant degradation when exposed to sunlight. The degradation is caused by the ultraviolet light component of sunlight, and can be reduced by adding cyanuric acid to the water. This chemical binds to chlorine and shields it from the ultraviolet light.

A number of studies have been performed on cyanuric acid, some of which suggest that the chemical decreases the effectiveness of chlorine, and therefore increases the disinfection time. To compensate for this effect, cyanuric acid needs to be maintained within a specific concentration range, and used in conjunction with higher levels of chlorine.

Techniques for measuring chlorine levels in water are well established. A variety of colorimetric techniques are available, using reagents and a comparator or photometer.

However, chlorine and pH levels alone are an insufficient measure of the efficacy of the disinfection process. The efficacy is determined by the activity level of the chlorine, which can be affected by a number of other factors.

The activity level of chlorine is measured by its oxidative capacity, otherwise known as the oxidation reduction potential. This parameter indicates the combined effect of all oxidising materials in the water, and is expressed in millivolts.

Systems which monitor the oxidation reduction potential and pH are becoming widespread in the aquatic industry, as they provide operators with the ability to automatically control the water chemistry.

Some indoor facilities choose to use bromine disinfectants in place of chlorine. Bromine compounds possess a number of desirable properties, including:

- Reduced breakdown of the disinfectant at higher water temperatures (heated facilities),
- Increased effectiveness of the sanitiser in water with high levels of organic contamination (produced by high bather loadings),
- Reduced patron irritation from sanitiser by-products (bromamines are less irritating than chloramines).

Bromine is most commonly used in a solid form as the chemical Bromo-chloro-dimethylhydantoin (BCDMH). The bromine and chlorine components of this substance eventually degrade to inactive bromide and chloride; however, the dimethylhydantoin (DMH) component does not break down, and accumulates in the water. Elevated levels of DMH are believed to produce skin irritation problems in patrons, and can only be reduced by dilution with fresh water on a volume by volume basis.

Bromine is not suitable for use in outdoor facilities, as it cannot be stabilised against ultraviolet light degradation.

The effectiveness of chlorine and other disinfectants is largely influenced by the pH of the water. Both chlorine and bromine lose their disinfection and oxidation capacity at higher pH levels. To ensure disinfectants achieve maximum effectiveness, it is critical that the pH of the water is maintained within a defined range.

Addition of disinfectants, which can be strongly acidic or strongly alkaline, changes the pH. Fluctuations in the pH levels can be minimised if correct alkalinity levels are maintained. The alkalinity is a measure of the ability of the water to resist changes in pH.

The appropriate alkalinity level will depend upon the type of disinfection system used, and the material used to construct the water body.

The chemicals used to disinfect the water and adjust the pH, ultimately break down to produce salt. Unless the salt level is diluted, by emptying a sufficient volume and refilling with fresh water, the salinity level will gradually rise.

The Total Dissolved Solids level (TDS) is a measure of the total quantity of salts dissolved in the water. It is advisable to prevent excessively high TDS levels from accumulating, as they may result in accelerated corrosion of metal components within the water bodies.

In addition to water chemistry, it is important to ensure physical water quality parameters are maintained.

Water clarity is often the first feature patrons notice when entering an aquatic facility. Apart from its effect on aesthetic quality, water clarity is also an important factor in providing a safe environment. Excessive levels of turbidity in water can reduce the ability of lifeguards to detect submerged patrons. The particles that produce turbidity also reduce the efficiency of the water disinfection process, by shielding micro-organisms from direct contact with disinfectants. A variety of methods are available to control turbidity levels.

Many aquatic facilities use water heating systems to facilitate patron comfort and enable the facility to be used throughout the colder months. The most appropriate operating temperature will depend on the type of facility.

Warmer temperatures are generally appropriate for facilities used for less strenuous activities such as hydrotherapy pools and spa pools, whilst lower temperatures are generally appropriate for facilities used for vigorous exercise, such as swimming training.

Higher water temperatures can cause patron discomfort, increasing perspiration and elevating levels of contamination in the water. If an aquatic facility is operated with excessively high water temperatures, and patrons stay in the water for long periods, they may suffer an elevation in body temperature, which can have serious consequences. As it is difficult to control the time patrons spend in the water, it is important to ensure water temperatures do not exceed certain limits.

It is important to regularly check the chemical and physical properties of aquatic facility water, and make adjustments where necessary. This will ensure the filtration and disinfection system is functioning correctly, and patrons are provided with maximum levels of hygiene and comfort.

## 5.1 CHEMICAL WATER STANDARDS

The water chemistry shall be maintained in accordance with the requirements of Table 6.

### 5.1.1 Free Chlorine Levels

**Table 6 – Minimum Free Chlorine Levels**

| | **Minimum Free Chlorine Levels – milligrams per litre** | |
|---|---|---|
| | **Water Temperature less than 26 $^0$C.** | **Water Temperature Greater than 26 $^0$C.** |
| Unstabilised pools – cyanuric acid not used. | 1.0 | 2.0 |
| Stabilised pools – where cyanuric acid is used | 2.0 | 3.0 |
| | **Minimum Free Chlorine Levels – milligrams per litre** | |
| Hydrotherapy Pools, Spa Pools & Wading Pools | 3.0 | |

*[Section 5.1.1 Free Chlorine Levels - Table 6 – Minimum Free Chlorine Levels amended 21 Sep 2009]*

As an alternative to complying with this requirement, indoor facilities may comply with the free bromine levels specified in 5.1.4 *Free Bromine Levels* of this Section.

### 5.1.2 Combined Chlorine Levels

It is recommended that facilities be operated with combined chlorine levels no greater than 30% of the Free Chlorine Levels.

### 5.1.3 Maximum Chlorine Levels

Total chlorine levels shall be no greater than 10 milligrams per litre whilst a facility is in use.

### 5.1.4 Free Bromine Levels

Facilities electing to use bromine sanitisers shall ensure the water complies with the requirements of Table 7.

**Table 7 – Minimum Free Bromine Levels**

| | **Minimum Free Bromine Levels (milligrams per litre)** | |
|---|---|---|
| **Type of Facility** | **Water Temperature Less than 26 $^0$C.** | **Water Temperature Greater than 26 $^0$C.** |
| Swimming Pools, Wave Pools, Water Slide Receiving Pools | 2.0 | 4.0 |
| Hydrotherapy Pools, Spa Pools and Wading Pools | 4.0 | 6.0 |

Facilities using bromine as a sanitiser shall keep the DMH levels no greater than 200 milligrams per litre.

### 5.1.5 pH

The pH shall be maintained within the range 7.2 – 7.8, except where bromine is used as a sanitiser wherein, the pH shall be maintained within the range 7.2-8.0.

### 5.1.6 Cyanuric Acid

Where cyanuric acid is used, it is to be maintained at a level of 30 – 50 milligrams per litre.

### 5.1.7 Alkalinity

The alkalinity shall be maintained within the range 60 – 200 milligrams per litre.

### 5.1.8 Calcium Hardness

The calcium hardness shall be maintained within the range 50-400 milligrams per litre.

### 5.1.9 Total Dissolved Solids

It is recommended that the Total Dissolved Solids (TDS) level be maintained at no more than 1000 milligrams per litre above the TDS level of the supply water, to an absolute maximum of 3000 milligrams per litre.

Facilities using salt water chlorination units shall maintain the TDS level in the range specified by the chlorination unit manufacturers.

### 5.1.10 Water Balance

It is recommended that operators ensure water is balanced in accordance with the Langlier Saturation Index, Taylor Index or other appropriate saturation index. Information on water balance is contained in Appendix 7 of this Code.

## 5.2 PHYSICAL WATER STANDARDS

Aquatic facility water needs to be maintained to appropriate physical standards, to provide patrons with a comfortable and safe environment, and to ensure the disinfection process works efficiently.

### 5.2.1 Water Clarity

Aquatic facility water shall be kept clean and clear.

The water shall be maintained to a level of clarity that will allow a Secchi Disk 150mm in diameter, placed on the bottom of the deepest part of the water body, to be visible when viewed from the concourse at a distance of 9 metres.

Whenever a facility is open for use, the water shall have sufficient clarity to enable lifeguards to see a submerged patron on the bottom of the water body.

This requirement shall be applied to measurements conducted on waterslide landing pools without the flume water flow operating.

### 5.2.2 Maximum Water Temperatures

Aquatic facility water bodies shall not be heated above 38 $^{0}$C.

## 5.3 MICROBIOLOGICAL WATER STANDARDS

All aquatic facility water shall be maintained in accordance with the microbiological requirements of Table 8.

**Table 8 – Microbiological Water Standards**

| Type of Organism | Maximum Count Allowable |
|---|---|
| Heterotrophic Plate Count | 100 Colony Forming Units (CFU) per mL. |
| Presumptive Total Coliforms | <1 per 100 mL |
| Presumptive *Pseudomonas spp*<br>(Only applies where water temperature is over 32 $^{0}$C) | <1 per 100 mL |
| Thermophilic Amoebae | Not Detected |
| Thermophilic *Naegleria* | Not Detected |

All make-up water used in aquatic facilities shall also comply with this requirement.

## 5.4 CHEMICAL WATER TESTING

Whenever an aquatic facility is open for use, the water chemistry shall be manually tested on a regular basis.

Operators shall undertake manual collection and testing of the aquatic facility's water chemistry at the required daily frequency using the approved manual water chemistry test kit. Under no circumstances are readings taken from automatic chemical controller gauges an acceptable substitute to manual testing.

The water testing shall include measurement of the following parameters:

- Free chlorine / Free bromine
- pH

The testing shall be performed in accordance with the following minimum frequencies:

- Group One Facilities: At least once every four hours
- Group Two Facilities: At least three times per day
- Group Three Facilities: At least twice per day
- Group Four Facilities: At least once per day

All facilities using isocyanuric acid shall perform water tests to measure the concentration of the chemical at least once per week.

Results of all water testing and maintenance procedures shall be recorded, and records kept by the facility for at least two years. The occupier of a facility shall produce the records for examination at the request of an Environmental Health Officer.

All chemical water tests are to be performed using water testing kits approved by the Executive Director Public Health. Approved testing kits are listed below:

- Palintest Comparators;
- Palintest Photometers;
- Lovibond Comparators;
- Lovibond Photometers.

Test kit reagents shall be stored in accordance with manufacturers' directions, and discarded upon reaching their expiry date. *[Section 5.4 Chemical Water Testing amended 15 Sept 2008]*

## 5.5 OFF-SEASON PERIODS - WATER QUALITY MAINTENANCE

During the off-season, whilst an aquatic facility is not in use, operators shall ensure water clarity is maintained and algal growth prevented.

Signage must be displayed at all entry points into aquatic facilities, clearly stating that the facility is closed for the winter, or words to similar effect regarding off-season closure.

Aquatic facilities shall receive sufficient maintenance to ensure they do not give off objectionable odours, become a breeding ground for insects, or create any other nuisance or safety hazards.

Maintenance of other water quality parameters is not required during the off-season.

At the end of an off-season period, occupiers shall seek approval from the Environmental Health Service of the local government in which the aquatic facility is located, prior to a facility being re-opened for use.