NSW HEALTH

DEPARTMENT OF HEALTH NSW

PUBLIC SWIMMING POOL AND SPA POOL GUIDELINES

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FOREWORD

Public swimming pools and spa pools may be divided into two distinct types:

- where the water is treated physically and chemically, and then recirculated, or
- where the water is untreated.

These guidelines consider both types of public pools.

A **treated water public swimming pool and spa pool** is one where the water is treated and recirculated. Typical examples included public pools where the water is filtered, disinfected and recirculated such as purpose constructed olympic swimming pools. Part A provides the guidelines for these public swimming pools and spa pools.

An **untreated water public swimming pool and spa pool** is one where water enters the pool or spa directly from a natural source either under its own flow or by pumping and where no control is exerted over the outflow of the water from the pool. Typical examples include tidal swimming pools, draw and spill pools, harbour pools and enhanced swimming holes where the pool may not be completely enclosed in a structure but where public bathing is intended. Part B provides the guidelines for these public swimming pools and spa pools and is further divided into natural pools which use surface waters and mineral pools which use subterranean mineral water.

PURPOSE

The essential purpose of this guideline is to specify **minimum** levels of chemicals and disinfectants as a health criteria for **treated** water public swimming pools and public spa pools. This document is not intended as a manual.

The guideline disinfectant values are to compliment the relevant provisions of the Public Health Regulation 1991. The regulation defines a public swimming and spa pools and a definition of these classes of pools is therefore not repeated in the guidelines.

The guidelines have equal application to all swimming pools and spa pools but were specifically drafted for application to the following pools:

- municipal swimming pools and spa pools,
- pools where the public, members and their guests, customers and patrons may have reasonable access as part of a service or workplace and includes:
    - hotels and motels
    - clubs
    - schools
    - gymnasiums & health resorts
    - squash and tennis centres
    - recreational resorts
    - hospitals (hydrotherapy pools)
    - workplaces, and
    - places of adult entertainment

The guidelines were not specifically designed to apply to private residential premises such as single and dual occupancy premises, flats, strata title residential premises, and retirement villages. The disinfection levels may however, still be used for these premises as they are relevant.

The guidelines for **untreated** swimming pools are intended to be used for natural swimming pools such as rivers, streams, water holes and applications of natural waters such as in draw and spill enhanced swimming situations.

PART A

TREATED WATER PUBLIC SWIMMING POOLS AND PUBLIC SPA POOLS

1 INTRODUCTION

All people who use public swimming pools and spa pools are susceptible to infection. Public pools are more likely to be contaminated with a greater diversity of disease causing organisms than domestic swimming pools because they are open to community contamination. Disease causing organisms may be introduced from many sources but are mainly associated with bathers. These organisms may be brought into a pool on the bathers skin, and in their saliva, urine and faeces. The organisms may also be introduced from dust, birds droppings, make-up water and soil carried on bathers feet. Some of these disease causing organisms live and may even grow in pool water unless the pool water is properly and continuously disinfected.

Disease causing organisms must be quickly and effectively killed in the pool water in which they are introduced, otherwise a disease may be transmitted. The swimming pool or spa pool needs to be designed and operated to enhance the action of the disinfectant. **All treated water public swimming pools and public spa pools shall be equipped with an effective water circulation system, filter and continuous disinfectant dosing control system**. Continuous dosing means the use of a metering device to feed a chemical at a relatively constant rate. Continuous dosing does not include the use of a floating dispenser containing a dissolving chemical.

The installation and use of automatic disinfectant dosing systems and pH correction systems using automatic controllers receiving feedback information from chemical sensing probes however, are strongly recommended.

These guidelines specify the **MINIMUM** chemical criteria (see Annexures B and C) by which a swimming pool and spa pool must be operated to minimise public bather risk to acceptable levels. It is important for people who are responsible for pool operation to maintain their pools at a standard equal to or greater than these guidelines at all times the pool is open to the public. Persons who are more susceptible to disease should be aware of their higher risk status and adopt suitable precautions.

2 DISINFECTANTS - GENERAL PROPERTIES

An ideal swimming pool and spa pool disinfectant would produce two extremely important distinct effects:

- a residual bactericidal effect; and
- an oxidation effect.

While some chemicals can do both, some chemicals can only disinfect or oxidise. Some chemicals may be bactericidal for a short time but rapidly dissipate to leave the pool without a residual protection. It is important to be able to measure the amount of disinfectant in the pool water or to be able to measure the disinfection power of the disinfectant. There is no ideal disinfectant as all disinfectants have their relative strengths and weaknesses. Before a disinfectant or disinfectant system is installed it is recommended that advice from a pool professional or consulting engineer be sought.

When a particular disinfectant or disinfecting system is chosen the criteria specified in the Annexures B or C must be followed. Some suitable disinfectants are:

2.1 CHLORINE

The disinfectant form of chlorine is "free residual chlorine." It is also known as “free available chlorine” or “free chlorine” and all terms refer to the concentration of hypochlorous acid and the hypochlorite ion in equilibrium concentration in the pool water. It is strong and safe when used properly and is still the most popular form of disinfection. There is much material available on the techniques of chlorination and "breakpoint chlorination" in particular; and it is excellent practice to attain breakpoint before the first chlorine measurements are taken each day. Breakpoint chlorination means that all of the chlorine is available as free chlorine. This is achieved by adding sufficient chlorine to burn out all the combined chlorine, so that free chlorine equals total chlorine.

The higher the pH above 7 the less the disinfection power of free chlorine. pH needs to be properly controlled in a swimming pool and spa pool when chlorine is used and automatic adjustment is recommended to levels between 7.2 and 7.8.
Free residual chlorine can also oxidise ammonia, some other organic compounds and some organic nitrogen introduced into the pool by urine or perspiration. Free chlorine however can combine with ammonia to form compounds, known as chloramines, which cause eye stinging and this reduces the ability of chlorine to disinfect particularly in indoor pools. Chloramines are also known as "combined residual chlorine" and should be kept to a minimum. This is done by adding more chlorine to oxidise them over a period of time without bathers in the pool. To explain this more fully an appropriate text should be studied (Australian Standard AS3633 for example).

Chlorine is available in many forms and not all forms are appropriate for all applications. Calcium hypochlorite (powdered or granular chlorine) for example should not be used in hot spas as it may promote scaling on heat exchangers and on hot water control valves which may lead to scalding. Cyanurated chlorine (stabilised chlorine) should not be used in indoor pools. Bromine may be used as a trace disinfectant to reduce the adverse effects of chlorine.

2.2 BROMINE

Bromine is a weaker disinfectant than its chlorine equivalent and to achieve similar disinfection bromine needs to be at concentrations of at least 50% to 60% higher than chlorine and this is recognised in the chemical criteria of these guidelines. Bromine reacts with nitrogenous compounds in a similar way to chlorine to produce bromamines. They do not however, cause the serious bather discomfort as do chloramines. There are fewer complaints of eye irritation and obnoxious chemical related odours when bromine is used as a disinfectant which makes bromine more suited to indoor pools. The test method cannot differentiate between free and combined bromine. This is not so important because free bromine and combined bromine have a similar disinfection efficiency.

Bromine may be used as bromochlorodimethylhydantoin (BCDMH) or alternately as a bromide bank system with activation by chlorine. Bromine is less stable than chlorine when exposed to ultra violet light but unlike chlorine cannot be stabilised and is therefore less suitable for outdoor pools than chlorine. A stabilised chloro/bromide system may also be considered.

As pH increases disinfection power is lost. However, the loss of disinfection power is less than that experienced by chlorine over the swimming pool and spa pool pH range of 7.2 to 7.8.

There have been reported cases of skin rashes and sensitisation to bromine systems where BCDMH (bromochlorodimethylhydantoin) was the disinfection agent. The sensitisation occurs over a period of time at excessive levels to produce contact dermatitis symptoms and individual sensitisation appears to be permanent. Further research is needed to assess this problem fully.

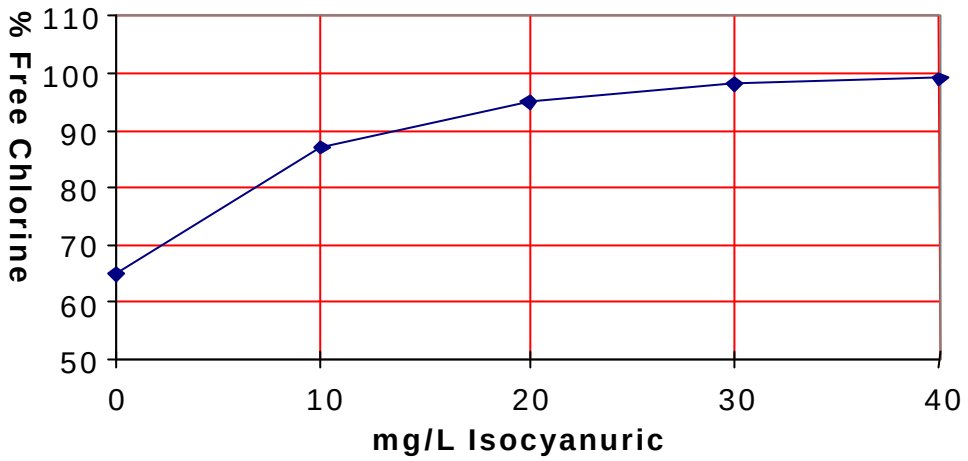
2.3 SALT WATER CHLORINATION (ELECTROLYSIS)

Salt water chlorination is the process of electrolysis of salt water. The electrodes produce chlorine and hydrogen in gaseous form at a constant rate determined by the salinity of the pool water. It is important to maintain correct salinity levels or the chlorination production rate declines. While hydrogen may be liberated as a gas the chlorine rapidly dissolves to form "free chlorine" and follows the usual chlorine swimming pool chemistry, except that the chloride ion may reform and be available again for conversion in electrolysis. Salt water chlorination does not have the ability to respond adequately to shock loadings and a backup continuous dosing system or a bank of electrolysis units should also be provided. Overnight and supplementary slug hand dosing with chlorine compounds may be required. Slug dosing should never be done within three hours before bathers are admitted to the swimming pool or spa pool or while people are bathing.

2.4 ISOCYANURATED CHLORINE COMPOUNDS (STABILISER)

Isocyanurated chlorine compounds and isocyanuric acid are used to stabilise chlorine against losses due to ultra violet light in direct sunlight. Chlorinated isocyanurates when dissolved in water provide free chlorine. All isocyanurated chlorine compounds (except sodium dichloroisocyanurate) when added to water tend to lower the pH by varying amounts. The use of isocyanurated chlorine is optional.

Graph 1: Chlorine Staying Power - One Hour



Research on outdoor pools has shown that chlorine residuals without isocyanuric acid had lost 90% of the chlorine residual on a sunny day in three hours. Pools containing 25 to 50 mg/L of isocyanuric acid under the same conditions lost only about 15% of the chlorine residual. No appreciable increase in chlorine stability occurred above 50 mg/L isocyanuric acid. Indeed, laboratory studies have confirmed the benefits of pool stabilising and shown that no appreciable increase in stability occurred above 30 mg/L isocyanurate over a one hour period as shown in Graph 1.

Further tests have shown that increased amounts of isocyanuric acid required three fold increased amounts of chlorine to achieve comparable disinfection rates. Laboratory tests using distilled water demonstrated the reduction in deactivation of *Pseudomonas aeruginosa* as the concentration of isocyanurates increased. Surveys of actual swimming pools using isocyanurates however, have demonstrated that concentrations of isocyanuric acid (up to 100mg/L) had little effect on the kill rate in the presence of ammonia nitrogen.

An excess concentration of isocyanuric acid can be reduced only by dilution effects of rainfall or by topping up after filter backwashing. Once the desired level of isocyanuric acid has been reached in the pool (20 to 30 mg/L) the pool operator may cease using isocyanurated chlorine compounds and change to using other chlorine compounds. **Isocyanurates must not be used under any circumstances in an indoor pool or indoor spa** because of decreased rates of kill of some disease causing organisms and the increase in the delay of initiation of kill. Isocyanurates do not have any effect on bromine nor do excessive levels pose a health risk.

2.5 OZONE

Ozone is an unstable blue gas with a characteristic pungent odour, and a molecular formula of O_3. It is produced commercially from clean, cool, dry air or oxygen formed by the discharge of high voltage (4000 to 30000v) electricity. Ozone may also be produced as a "by product" by specific wavelength ultraviolet lamps. At air concentrations of 0.25 mg/L it is considered injurious to health. Its occupational threshold limit value is 0.1 mg/L in air. At 1.0 mg/L in air it is extremely hazardous to health.

It is a short lived, unstable but powerful oxidising and disinfection agent which does not react with porcelain or glass. Ozone disappears quickly from water. This is advantageous from the point of view that such a hazardous agent quickly disappears but disadvantageous from the point of view that no satisfactory disinfectant residual is provided in the pool itself. Ozone may not be used as the sole disinfectant in a public swimming pool or public spa pool but may be used in conjunction with chlorine or bromine. Where ozone is used with chlorine a reduction of free chlorine is permitted provided mainstream ozonation is practised and the ozone is quenched using a bed of activated carbon preventing ozone from degassing in the swimming pool.

Where ozone is used in conjunction with bromine an activated carbon filter bed is not required provided that there is always an excess concentration of bromide in the water to ensure the complete destruction of residual ozone.

2.6 POLYHEXAMETHYLENE BIGUANIDE ("BAQUACIL" ®) AND HYDROGEN PEROXIDE

The disinfection system relies on the bacteriostatic properties of "Baquacil®" and a fortnightly shock dose of hydrogen peroxide for oxidisation. Its recommendation as a pool disinfectant was made as a result of field trials in NSW and is accepted by the NH&MRC and overseas as a domestic pool size disinfecting system (less than 100,000 litres). 'Baquacil®" is not well suited to handling shock loads but it does aid in the flocculation and removal of contaminants by filtration. It cannot be used in spa pools due to excess foaming.

Table 1: Disinfectant Summary

Satisfactory Disinfectant	Unsatisfactory Disinfectant
Chlorine	Ultraviolet Light and Hydrogen Peroxide
Isocyanurated Chlorine in outdoor pools	Iodine
Bromine	Silver/Copper Electro-Katadyn Process
Chlorine/Bromine Systems	Hydrogen Peroxide
Ozone with Chlorine	Magnetism
Ozone with Bromine	
Polyhexamethylene biguanide in domestic sized pools <100,000 litres	

3 CHEMICALS

3.1 OTHER CHEMICALS

There is a wide range of chemicals which may need to be used in the treatment of swimming pool water apart from disinfectants. The main common named chemicals are:

SODA ASH - (Sodium carbonate) is a strong alkali powder or liquid, which is used to quickly raise the pH of a pool. Soda ash should not be added to a pool by slug dosing but should be added slowly and gradually over an extended period. This is a dangerous chemical and should be handled with care.
DRY ACID - (sodium bisulphate) is a strong acid powder, which may used to quickly reduce pH. Dry acid should not be added to a pool by slug dosing, but should be added slowly and gradually over an extended period. This is a dangerous chemical and should be handled with care.
MURIATIC ACID - (hydrochloric acid) is a strong acidic liquid which may also be used to reduce pH quickly particularly when the reserve alkalinity is greater than 120 mg/L. This is a dangerous chemical and should be handled with care.
CARBON DIOXIDE - (CO_2) is a gas which when added to water forms a weak acid (carbonic acid) and may be used to reduce pH when the reserve alkalinity is less than 120 mg/L. It is best used in an automated pH correction system.
BICARB - (sodium bicarbonate) is a weak alkali powder, which is used to raise total alkalinity. Slug dosing will not raise the pH to greater than 8.3.
ALGAECIDES - algae are relatively harmless to humans but they may make the pool unsightly, may cause colours, promote bacterial growth, assist in the formation of chloramines and their presence indicates poor pool maintenance. From a safety point of view algae cause slippery pool walls, pool bottoms and walkways. Algae can be introduced into a pool in the form of airborne spores, blowing free in the air attached to dust or enveloped by raindrops. They are mainly associated with outdoor pools as they require sunlight to grow.

The most uniformly accepted algal control procedure is to maintain a free chlorine residual of between 1 to 2 mg/L or where pools are warmer than 26 C a minimum 3 mg/L concentration. A successful technique for algal control is to frequently superchlorinate the swimming pool to 10 mg/L particularly after windy conditions and rainfall. The use of a pool cover to prevent contamination and reduce light intensity may also be helpful. There are a range of algaecides available on the market and their compatibility with the disinfectant system should be determined at the point of sale. Algaecides are an adjunct to pool conditioning for winter.

3.2 STORAGE OF CHEMICALS

The storage and handling of bulk chemicals is controlled under the Dangerous Goods Act 1975 and administered by the WorkCover Authority. Pool operators should consult with this authority for precise requirements.

Chemicals should be stored separately in well labelled, dedicated, air tight containers and they should never be allowed to mix. Chlorine based chemicals should never be mixed with acids as the dangerous chlorine gas may be liberated. Oxidising agents such as disinfectants should not be allowed to remain in contact with organic matter as spontaneous combustion may occur. Fires may only be extinguished with copious quantities of water.

The following twelve rules should be observed:

1. Ensure all chemical containers are labelled and follow all instructions implicitly.
2. Store chemicals separately from each other.
3. Store chemicals in a cool, clean, dry, well ventilated, secure area to prevent access by children. Store above ground level to minimise spills, and do not store liquid chemicals above dry chemicals.
4. Wear appropriate protective impervious gloves and goggles when handling chemicals.
5. Wash hands before and after handling chemicals.
6. Avoid contact with chemicals on skin and eyes, and avoid breathing vapours.
7. Use a separate scoop for dispensing each chemical.
8. Always add the chemical to clear, clean water and never add water directly to a chemical.
9. Avoid spillages and clean up any spillage immediately.
10. Remove chemical contaminated clothing immediately.
11. When not in use keep chemical containers sealed with original closure.
12. Empty containers should be washed before disposal.

4 AUTOMATIC CONTROL AND DOSING

Continuous dosing refers to the use of a metering device to feed a chemical at a relatively constant rate. Continuous dosing does not include the use of a floating dispenser containing a dissolving chemical. Automatic control and dosing however, refers to a continuous dosing system activated and controlled by feedback from electronic chemical sensing equipment.

There are two methods of automatic control and dosing of disinfectant. They are by the use of amperometric probes measuring disinfectant residuals or by the use of high resolution oxidation-reduction potential detection probes (ORP or redox). Automatic control may also be exerted over pH.

The amperometric method is designed to measure free available chlorine. The amperometric method may be also used to measure other disinfectants. The results obtained may be used to automatically adjust feed rates of dosing mechanisms providing a greater degree of control over disinfectant usage and compliance with standards particularly as pool bathing loads change.

Much less is understood by pool operators about the principal of redox measurement which measures the total disinfecting power of all oxidising disinfectant forms in the pool water once set to the correct initial oxidation potential. The signal from the redox probe may be used to automatically dose the pool water. The required redox potential for disinfection will vary slightly between disinfecting systems and is also dependent on the basic water supply potential which must be assessed and taken into account when the control system is initialised. Redox potential from 700mV to 750mV are appropriate and are reflected in the chemical criteria.

The installation of automatic control and dosing systems for disinfectant and pH control although optional at this stage is strongly recommended.

5 CONSTRUCTION AND AMENITIES

5.1 POOL LAYOUT AND SIZE

A well designed pool shape and water distribution system will reduce the occurrence of dead spots and enhance the action of disinfection. Pool water should be supplied through protected inlets at a pressure that will not "throw" incoming water into the face of a bather. Scum gutters or overflow weirs are extremely important to

remove contamination should be provided at least along two opposite sides. The maximum instantaneous bather load may be calculated using Table 2. Pool depth should be marked at regular intervals.

Table 2: Bathing Load According to Water Depth

Water Depth (m)	M^2 per person
< 1m	3
1m to 1.5m	4
> 1.5m	4.5

5.2 POOL CONSTRUCTION

The pool should be constructed using smooth, impervious materials capable of easy cleansing, and be light in colour. There should be no projections into the pool and ladders and lane divider hooks should be recessed. The pool surrounds should extend at least 1m from the pool and should be graded away from the pool and drained to waste. The surrounds of indoor pools should also be drained to waste to prevent extraneous chemicals from entering and placing excessive demands on the pool circulation system. Care should be taken to ensure that the pool surround is not slippery when wet and that all butt joints are flush to prevent injury. Foot baths are not recommended.

5.3 WATER TEMPERATURE

Where spa pools are heated the temperature must never exceed 38 C and signs should be displayed restricting bathing to 20 minutes at this temperature. Warmer temperatures favour bacterial growth, such as *Legionella* in filter media, which may be transmitted by aerosols in spa pools. *Pseudomonas aeruginosa* survival and growth is enhanced at pool temperatures exceeding 26 C and this fact is reflected in the chemical criteria.

5.4 POOL PLANT AND TURNOVER RATES

Pool plant should be designed to meet the following maximum pool volume turnover periods (exclusive of balance tanks):

Table 3: Maximum Pool Turnover Periods

Pool Type	Turnover Period (maximum)
Spa and bubble pools	Hour
Pools < 0.5m deep	½ hour
Pools > 0.5m but < 1.0m deep	1 hour
Pools > 1.0m but < 1.5m deep	1½ hour
Pools > 1.5m but < 1.8m deep	2 hour
Pools > 1.8m but < 2.0m deep	2½ hour
Pools > 2.0m but < 3.0m deep	3½ hour
Pools > 3.0m deep	5 hour

The above maximum turnover periods should be applied to all pools on a zoned basis such that the water distribution system serving a varying depth pool is designed to produce different turnover rates as required.

Filtration systems should run 24 hours per day except when backwashing. The pool plant for public pools must provide continuous dosing of disinfectant and continuous filtration while the plant is in operation. A balance tank should be considered in the design of pools where the depth exceeds 1m.

Due to recent outbreaks of *Cryptosporidium*, which is introduced through accidental faecal contamination, it has been recommended that pools patronised by non-toilet trained toddlers should have a separate circulation system. The cysts of *Cryptosporidium* are not totally removed by filtration as the cyst size is about 4 - 6

microns where most filters remove particles greater than 10 - 15 microns. Flocculation and coagulation agents assist in cyst removal only from the water passing through the filter and not the remaining body of water in the pool. Successive filtration turnovers eventually reduce the numbers of cysts. Fortunately, the cysts do not multiply in swimming pool water as they need a host animal.

5.5 DRESSING ROOMS

Floors should be coved at corners, graded and drained. Matting made from natural or woven materials should not be used. Adequate artificial and natural lighting and ventilation should be provided. Benches should be constructed of smooth impervious material and if wood is used it should be maintained by a lacquer or tough paint in a light colour. All floors, walls and ceilings should be light in colour. Lockers should be inspected and cleaned weekly.

5.6 CLOSETS

Closets should be located within the dressing room close to the pool entry at rates specified by the local authority and/or the Building Code of Australia. It is extremely important to encourage toileting prior to bathing as urine is the most polluting material to enter a pool or spa.

Closet numbers should be designed for intended loads. Additional closets may be necessary for spectator areas in larger pool and complexes. Closets should be cleaned twice daily and toilet paper provided. Provision should be made for separate disposal of sanitary pads, napkins and tampons.

5.7 SHOWERS

An adequate number of showers should be located in the dressing room in positions where patrons have to pass by them before entry to the pool area to encourage pre-showering. Soap should also be provided when possible. Signs should be erected to encourage showering before swimming. Cleaning should be performed daily with disinfection of shower floors and weekly scrubbing to remove soap accumulation. Where a warm water supply is provided at 42 C is used the local authority should be consulted about Legionnaires' disease control.

5.8 HANDBASINS

Handbasins should be located adjacent to closets and ideally soap should be provided.

5.9 GARBAGE

Adequate garbage bins should be provided particularly in the spectator and lawn areas, and adjacent to the kiosk. Bins should be emptied as necessary and the garbage bagged or bin liners used. Bulk garbage should be stored in a secure area and should preferably be located in the shade. The storage area should be maintained in a clean condition and free from vermin.

5.10 KIOSK

The kiosk shall comply with the provisions of the Food Act, 1989, and local authority food premises codes. No products including food products should be sold in glass.

5.11 TEST ROOM

A separate area or room away from the chemical storage area should be provided where testing of pool water may be carried out. The test room should be provided with a sink and tap water, and adequate bench space.

5.12 FIRST AID

First aid equipment and a sick bay should be provided as appropriate.

5.13 SHADE

The use of an outdoor swimming pool complex by patrons exposes them to harmful ultra violet radiation. The "Sun Protection Policy Guidelines for Local Government" produced by the Australian Institute of Environmental

Health (NSW) is endorsed by the Cancer Council NSW and the NSW Health Department. It contains valuable specific guidelines for outdoor public swimming pools.

5.14 VENTILATION

Adequate fresh make up air for indoor pools is necessary to dilute volatile air contaminants. Where a cooling tower is provided in a water cooled ventilation system it should be registered with the local authority and comply with the microbial control provisions of the Public Health Act, 1991.

6 HYGIENE

6.1 TOWEL AND COSTUME HIRE

Towel and costume hire is not recommended but where provided separate storage facilities should be provided for clean and used costumes and towels. Used costumes and towels should be laundered as soon as possible, using commercial laundry facilities.

6.2 SPRINGBOARDS

Springboards should not be covered with matting.

6.3 POOL CONTAMINATION

All patrons (including infants) should be required to wear bathing briefs as a large number of diseases are transmitted through human faecal accidents. An oxidation reduction potential (ORP) of 860mV for 20 minutes is reported to produce a 99%oocyst reduction of *Cryptosporidium*, as will an ORP of 800mV over 2 hours (3 mg/L free chlorine at pH 7.2). It is good practice to "super disinfect" (superchlorination to 10 mg/L) overnight on a weekly basis to overcome possible resistance development and to kill most cysts which may be introduced into the pool.

All persons should be encouraged to use closet and shower facilities before entry into the pool. Persons detected with open wounds, sores and rashes, infected eyes, or wearing bandages should be requested not to swim in the pool. Pool contamination through nose blowing, spitting and spouting of water should be actively discouraged.

Each pool premises should determine its attitude toward the control or possible exclusion of incontinent persons who might use the pool. Pool disinfection systems are not designed to accept or disinfect faecal material. However, a suitable management plan may need to be devised for specific pools, such as hydrotherapy pools frequented by special groups such as incontinent and/or immuno-compromised persons. Suitable signs should be erected near the main entrance.

The pool should be maintained in a clean condition, free from debris, and floating materials by frequent vacuuming and skimming. Walls, floors, overflow weirs and scum gutters should be kept free from debris, body grease and algal blooms. No animals except guide dogs assisting blind persons should be permitted on the pool premises.

6.4 EMERGENCY CONTAMINATION MANAGEMENT

If a substantial amount of **loose runny stool (diarrhoea)** is introduced into the pool:

- the pool in the vicinity of the faecal accident should be cleared of people,
- the faecal material should be removed as thoroughly as possible using a fine mesh,
- check the disinfectant levels in the pool vicinity and if below required levels then close the pool immediately,
- add a coagulant and filter for at least one turnover before allowing patrons to use the pool,
- superchlorinate overnight,
- thoroughly vacuum the pool,
- backwash the filter, and
- enter all relevant details on the log sheet.

When a **solid stool** is introduced into the pool the immediate vicinity should be evacuated. The stool should be removed as soon as possible and a check made of disinfectant levels in the vicinity. Where disinfectant concentration is low the pool should be closed for one pool turnover. Where disinfectant levels are satisfactory allow swimming to continue.

Where **blood or vomit is introduced into a pool** it should be temporarily cleared and the contamination dispersed until there is no further trace. Tests for disinfectant levels should be satisfactory before allowing people to swim.

Blood spillage on the poolside should not be washed into pool side drains. It should be neutralised with a 1% chlorine solution (household bleach or a 10:1 dilution of sodium hypochlorite) for two minutes before being washed away.

7 TESTING

7.1 FREQUENCY OF TESTING

Testing should be carried out in accordance with the frequency specified by table 4:

Table 4: Testing Frequencies

Test	Minimum Manual Testing Frequency
Continuous non-automatic control dosing: • Free Chlorine • Total Chlorine (Combined Chlorine) • Total Bromine • pH • Polyhexamethylene biguanide	Prior to opening and thence two hourly
Automatic control dosing: • Free Chlorine • Total Chlorine (Combined Chlorine) • Total Bromine • pH • Redox Potential	Prior to opening and then once during the day to confirm automatic readings. (Automatic readings should be logged four hourly).
• Ozone • Reserve (Total) Alkalinity	Daily
• Isocyanuric Acid • Clarity • Water Balance • Bromide (Sodium bromide systems) • Total Dissolved Solids • Bacteriological Sampling (first two months)	Weekly
• Bacteriological Sampling (after first two months) • Dimethylhydantoin (BCDMH systems)	Monthly

7.2 SAMPLING LOCATION

Water samples for testing **all chemical parameters except ozone** should be collected immediately prior to carrying out the test. Water should be sampled from a depth of at least 300mm using an inverted plastic beaker in a location representing a point **furtherest** from inlets, or by assessment of various locations to determine the area of lowest readings.

Water samples for testing **ozone** should be collected immediately prior to carrying out the test. Water should be sampled from a depth of at least 300mm using an inverted plastic beaker in a location representing a point **closest** to an inlet.

Samples for confirming automatic control dosing should be taken from a sample tap strategically located on the return line as close as possible to the probes in accordance with the manufacturers instructions. As the difference between manual pool readings and automatic control measurements will vary, it is the consistency of variation that is paramount. Diverging or converging readings should be investigated.

Bacteriologic samples should be collected prior to its complimentary chemical parameter sampling. (Note: Bacteriological samples must be collected in sterile containers containing sodium thiosulphate and during times of high bather load.)

7.3 TESTING APPARATUS

Suitable testing apparatus shall be used to ensure accurate results. Fresh reagents sealed in foil and in accordance with manufacturers specifications should be purchased just prior to the swimming season or at least once a year. All glassware and plasticware should be thoroughly washed and rinsed after each testing session. The test methodology specified by the manufacturer of the test kit should be strictly followed. Liquid testing reagents must be stored in sealed containers. Test kits using orthotolidine as a reagent to determine chlorine or bromine have been withdrawn from sale because of the carcinogenic properties of the reagent.

Plastic or perspex kits known as "4 in 1" or "5 in 1" kits are not suitable for testing public swimming and spa pools. The following test methods are considered suitable:

a) Chlorine / Bromine

- A colorimetric comparison method based on DPD reagents using standards capable of measuring to 0.2 mg/L units within the recommended disinfectant range; or
- A photometric method based on DPD reagents capable of measuring to 0.2 mg/L units within the recommended disinfectant range.

b) Polyhexamethylene biguanide ("baquacil®")

- The only test kit available is marketed by Aquaswim Pty Ltd.

c) Ozone (Note: This method is still under development as chlorine and bromine may interfere with the result - the supplier should be consulted for appropriate methodology.)

- A colorimetric comparison method based on DPD reagents using standards capable of measuring to 0.1 mg/L; or
- A photometric method based on DPD reagents capable of measuring up to 0.1 mg/L.

d) Hydrogen Peroxide

- A colorimetric comparison method based on potassium iodide under acidic conditions using standards and capable of measuring to within 10 mg/L within the range of 0 - 100 mg/L; or
- A photometric method based on potassium iodide under acidic conditions and capable of measuring to within 10 mg/L within the range of 0 - 100 mg/L.

e) pH

- A photometric method capable of measuring to 0.1 pH units; or
- A pH meter; or
- A colorimetric method capable of measuring to 0.2 pH units.

f) Total Alkalinity

- Titration method using an appropriate indicator (and sodium thiosulphate where elevated chlorine concentrations are detected).

g) Isocyanuric Acid

- Any test kit available.

h) Clarity

- There is no test specified at this time for water clarity. Water clarity should be maintained so that lane markings or other features on the pool bottom at its greatest depth are clearly visible when viewed from the side of the pool.

8 RECORD KEEPING

A register or log should be used to record the results of every test performed at a swimming pool, spa pool or pool complex. There is a wide variety of test register sheet designs which vary according to the type of pool and

disinfectants used. There is no ideal test register sheet. Each pool or pool complex should design its own test register sheet according to local needs and recognising the requirements of Section 7.

A daily register sheet is essential which includes the testing times of each pool each day and cells for data entry of:

- date and time
- disinfectant concentrations (and ORP),
- pH,
- total alkalinity
- temperature and
- bathing loads.

Other entries that may be made include:

- backwashing,
- total dissolved solids,
- chlorine bottle usage,
- cyanuric acid concentration,
- water meter reading,
- electricity meter readings,
- admission data,
- dose settings,
- mechanical maintenance items,
- chemical stocks on hand,
- weather,
- water balancing, and
- general remarks.

One person should be made solely responsible for pool testing and recording of results each working shift and the register sheet should bear their name.

9 OPERATOR QUALIFICATIONS

A pool operator is the person nominated to be in charge of the pool and this should be a person dedicated on site specifically to control the pool or recreational centre operations. Operators of public pools should have a sound knowledge of pool operating procedures. At present there are no legislative requirements for qualifications of swimming pool operators. While some written information can be obtained a training course is considered to be more appropriate and the Aquatic and Recreation Institute should be consulted.

Pool operators should have a sound knowledge of:

- pool plant,
- pool maintenance,
- pool disinfection requirements,
- water testing,
- first aid and
- life saving and resuscitation techniques.

For further information please consult "Safety in Swimming Pools, Guidelines for Safe Pool Operation" The Royal Life Saving Society NSW Branch, 129 Victoria Road, (PO Box 753) Gladesville, 2111, telephone (02) 9879-7177 or "Swimming Pools on Public Land - Water Safety", Practice Note No. 10, November 1994, NSW Department of Local Government, 66-72 Rickard Rd, Bankstown, 2200, telephone (02)9793-0793.

10 WATER BALANCING

Pool professionals place great importance on water balancing and this view is supported but is not a requirement of these guidelines.

The term "chemical water balance" means that the swimming pool water is in a state of equilibrium with calcium compounds. A balanced water prolongs the life of a pool and its fittings, assists with preventing stains and improves bather comfort. If pool water does not have enough dissolved salts it will try to obtain them by

etching or eroding the pool surfaces and fittings. If the pool water has too much dissolved salts it will try to get rid of the excess in the form of salt precipitates or deposits known as scaling.

The three major factors which operate interdependently affecting water balance are pH, total alkalinity and calcium hardness. As pH rises, salt solubility decreases and therefore, in hard waters with a high alkalinity, scaling may occur. As total alkalinity rises, again the solubility of salts tends to decrease and again in hard water with a high pH, scaling may occur. Calcium hardness is a measure of all the different dissolved calcium compounds found in the pool. If calcium hardness is low it does not cause problems in a pool unless the water is not chemically balanced. If calcium hardness is too high it again may not cause problems unless the water is not chemically balanced. Temperature affects the solubility of salts in a pool. Generally a salt is less soluble in water at higher temperatures (boilers and heat exchangers) than at lower temperatures.

Annexure D to these guidelines explain how to determine a chemical water balance.

11 TOTAL DISSOLVED SOLIDS

Total dissolved solids (TDS) is a measure of all soluble matter dissolved in pool water. Mains water often has a TDS of several hundred mg/L. All chemicals added to a pool, particularly chlorides and sulphates, increase the TDS level and a high level is an indication of chemical overload or lack of dilution of pool water. The TDS of the pool should be regularly compared to that of the mains water. As a general rule TDS should not rise greater than 1,000 mg/L above the mains water and should not be permitted to rise to an absolute of 3,000 mg/L. TDS is lowered by regularly dumping of water and adding fresh water. This has lead to the popular conception in spa pool management in particular that a minimum of one quarter of the spa water should be dumped each week.

12 HEALTH RISKS

In poorly maintained swimming pools and spa pools people may be at risk from infections caused by a number of microorganisms some of which may be naturally present on our hair or skin or in our ears, mouths, noses, intestinal and uro-genital tracts. The infections may be transmitted by inadequately treated pool water or surfaces (such as shower floors).

12.1 BACTERIAL PATHOGENS

Pseudomonas aeruginosa is the most common disease causing agent associated with waterborne disease outbreaks. It is an opportunistic pathogen and has been identified as the causative agent of eye, ear and skin infections. Its normal habitats are water, soil and vegetation but may also be of human origin. Although relatively resistant to a range of disinfectants, chlorination of normal swimming pools should be sufficient to kill the bacterium. However, in environments which are peculiar to spas such as water turbulence, elevated temperature and heavy bather-loads, considerably greater care is needed to ensure their safe operation and the eradication of this organism.

Legionella spp. causes a serious pneumonic disease known as Legionnaires' disease and a less debilitating disease called Pontiac fever. They are found in the natural environment, such as soil, rivers, lakes and creeks. The great majority of outbreaks have been associated with air conditioning cooling systems although spa pools have also been implicated. Legionellosis is caused through inhalation of contaminated aerosols.

Coagulase positive staphylococci have been regularly isolated from swimming pools and spa pools as they are normal microflora of the skin, ear and nose. These microorganisms can cause skin infections, such as boils, carbuncles and wound infections. They are fairly resistant to disinfection but have not been shown to be a public health problem in well maintained pools.

Mycobacterium marinum causes chronic skin ulceration known as "swimming pool granuloma" which may last up to three years if untreated.

Shigella, Salmonella and Campylobacter have been implicated as causative agents of gastrointestinal diseases but outbreaks as a result of swimming are uncommon.

12.2 PROTOZOAN PATHOGENS

Cryptosporidium and Giardia**,** are protozoan single celled organisms which a may be excreted by infected humans into swimming pools through faecal accidents and may cause outbreaks of diarrhoea. A carrier state exists where humans may be infected without showing obvious symptoms. **Chlorination** at recommended residual levels has limited effect on ***Giardia*** and is completely ineffective against ***Cryptosporidium*** oocysts. Regular "dumping" and filtration using flocculation and coagulation agents of pool water and regular superchlorination to 10 mg/L aid in the removal of these parasites. It is more important to prevent the entry of these organisms into the pool and strategies such as requiring all bathers to wear swimming costumes at all times or exclusion of incontinent persons should be considered as appropriate strategies.

Naegleria fowleri is a pathogenic free-living amoeba which has been shown to cause a fatal disease called **primary amoebic meningo-encephalitis.** The disease is contracted by the invasion of the amoeba through the nose into the brain. In nature, the organism thrives in mineral springs, thermal bores, rivers and lakes. These waters are generally heated above 25 C, which assists the parasite in its metabolism and survival.

12.3 VIRAL PATHOGENS

Enteroviruses are the major causative agents of swimming pool **gastroenteritis,** They are most frequently found in wading pools used by infants and young children where bather hygiene is poor and water volume is small.

Adenoviruses types 3 and 4 cause **pharyngo-conjunctival fever** amongst bathers. The disease is characterised by sore throat, fever and conjunctivitis frequently associated with diarrhoea.

The Herpes simplex virus causes fever and an unwell feeling. It has been reported to be able to survive for long hours in warm, humid conditions and is spread by persons with cold sores.

Plantar warts are caused by a papovavirus through contaminated floor surfaces.

12.4 YEAST AND FUNGAL PATHOGENS

Large numbers of fungi can be found in indoor swimming pools. Athlete's foot or tinea pedis is caused by ***Trichophyton mentagrophytes*** which has been isolated from the wooden flooring of a shower stall.

The yeast, ***Candida albicans***, causes urino-genital, skin and nail infections in individuals with normal immune defences as well as serious systemic infections in debilitated patients.

12.5 SKIN TANNING - NATURAL & ARTIFICIAL

Natural (Sun Bathing). Unfortunately it is a socially desirable condition that fair skinned persons acquire a tan. What people of celtic origin do not realise is that too much sun, burns and dries their skin and leads to premature wrinkling (ageing of the skin) and a higher rate of skin cancer and melanoma. This is reduced by using a special barrier cream and by avoiding prolonged exposure.

Artificial Skin Tanning. There are different models of solariums which use short wave (UVB) or long wave (UVA) ultra violet light. Short wave (UVB) tans the skin of most people. It also burns, ages and wrinkles the skin by destroying collagen (elastic tissue). Once lost, elasticity cannot return. Prolonged UVB exposure causes flaking and if allowed to continue goes on to a horny skin cancer.

Long wave (UVA) ultra violet light does not burn or tan as rapidly as UVB and hence, its effects are under-estimated. By itself UVA is not a strong promoter of skin cancer but as some UVA tubes also emit UVB light, this augments the carcinogenic producing property of UVB. UVA can also sensitise a person's skin. This is called photo sensitivity. Drugs like chlorpromazine (a tranquilliser), certain antibiotics and antifungal agents, some contraceptive pills and scents or cosmetics can cause pigmentation or skin rashes. Tinted safety goggles are recommended to prevent eye damage. Minor irritation can cause itchy, red eyes and chronic over-use could give rise later to cataracts.

All equipment should have automatic cut-off timers and patrons should be warned of any adverse effects by means of notices warning people of the danger to vision and side effects to those taking certain medications.

12.6 HEAT ILLNESS

In natural sunlight the main forms are heat exhaustion and severe sun burn. The body has no mechanism to warn of overheating. In saunas, dehydration, heat exhaustion and fainting may occur. On entering a heated pool or sauna the skin blood vessels dilate to help lose heat and keep the body cool. The heart has to pump faster and so the heart rate increases. If there is insufficient blood going to the brain, there is a lack of oxygen and a person may feel dizzy and even faint. Deaths have resulted when alcohol has been consumed and the body subjected to heat stress.

Heat exhaustion is caused by a loss of water and electrolytes. Any sustained muscular exertion can cause this. It is relieved by rest, fluid and electrolyte (salt) replacement. Proper conditioning prior to heavy muscular exertion should be attempted.

No heated swimming pool or spa pool should be operated at a temperature greater than 38 C and exposures at greater than body temperature should not exceed 20 minutes for a healthy adult. Children and those with medical conditions (heart conditions) are particularly at risk and should seek medical advice. A suitable warning sign such as “Children under the age of 6 years and persons with medical conditions should not use the heated spa pool. Seek medical advice.”

12.7 CHEMICAL CONDITIONS

While too little residual chlorine will allow bacteria to grow, too much chlorine, bromine or prolonged swimming, particularly in salt water can cause conjunctivitis (eye irritation) and dermatitis (skin allergy) and dry scaly skin. Bromine particularly in the form of BCDMH is believed to cause permanent skin sensitivity.

13 BACTERIOLOGICAL STANDARD FOR TREATED WATER PUBLIC POOLS

To ensure that a public swimming pool or public spa pool does not pose a risk to the health of the general public the pool water should be tested for certain organisms using the methods set out in Table 5 of Annexure A. Other test methods may be used provided that they have superior or equivalent sensitivity. Public swimming pool water and public spa pool water which is tested according to Table 5 of Appendix A is considered safe at the time of sampling when the test results comply with the bacteriological standard set out in Table 6 of Annexure A.

It is recommended that a bacteriological sample for each public swimming pool and public spa pool be submitted to a NATA or equivalent registered private analyst every month of continuous operation. Immediate resampling for bacteriological analysis should be performed when unsatisfactory results are obtained.

The results of a single sample do not give an indication of overall pool management. The bacterial results obtained should be entered into a database together with the complimentary chemical analysis so that baseline data is obtained on the pool management performance. These results should also be compared to bathing loads at the time of sampling to reflect the impact of this important pool operating parameter.

14 CHEMICAL STANDARD FOR TREATED WATER PUBLIC SWIMMING AND SPA POOLS

Because there is a delay of some days before the results of a bacteriological analysis is known, the chemical quality of the swimming pool water will provide a measure of its "on the spot" ability to combat infection as it is introduced into a swimming pool or spa pool.

The water in a public swimming pool or public spa pool shall be maintained in conformity with the following minimum standards at all times the pool is available for use by bathers, unless the Department grants specific dispensation for the use of a material, process, apparatus or device which is not capable of conforming with the listed standards.

14.1 PUBLIC SWIMMING POOLS

The standards for public swimming pools are contained in the following Annexures:

14.1.1 CHLORINATION OF A PUBLIC SWIMMING POOL - ANNEXURE B1
14.1.2 BROMINATION OF A PUBLIC SWIMMING POOL - ANNEXURE B2
14.1.3 OZONATION WITH CHLORINATION OF A PUBLIC SWIMMING POOL - ANNEXURE B3
14.1.4 OZONATION WITH BROMINATION OF A PUBLIC SWIMMING POOL - ANNEXURE B4

14.1.5 POLYHEXAMETHYLENE BIGUANIDE (BAQUACIL ®) DISINFECTION OF A PUBLIC SWIMMING POOL - ANNEXURE B5

14.2 PUBLIC SPA POOLS

The standards for public spa pools are contained in the following Annexures:

14.2.1 CHLORINATION OF A PUBLIC SPA POOL - ANNEXURE C1

14.2.2 BROMINATION OF A PUBLIC SPA POOL - ANNEXURE C2

14.2.3 OZONATION WITH CHLORINATION OF A PUBLIC SPA POOL - ANNEXURE C3

14.2.4 OZONATION WITH BROMINATION OF A PUBLIC SPA POOL - ANNEXURE C4

PART B

UNTREATED WATER PUBLIC SWIMMING POOLS

A natural pool is one which receives or utilises natural untreated water and may be the local swimming hole or an enhanced natural pool where facilities such as retaining walls, enclosures, amenities and other structures and partial structures have been constructed. In these pools the water is not recirculated.

It is common sense to use such a resource wisely for its intended purpose and to exclude those activities which are not compatible with bathing or represent a source of contamination.

The National Health and Medical Research Council (NH&MRC) has published "Australian Guidelines for Recreational Use of Water (1990)." These guidelines consider the three recreational categories of primary contact, secondary contact and passive recreation.

- Primary contact considers total body immersion where water could be ingested.
- Secondary contact considers physical contact with the recreational water but where ingestion is unlikely.
- Passive recreation is where no contact is made with the water.

To facilitate an assessment of an untreated water public swimming pool the NH&MRC guidelines for **primary and secondary contact** should be utilised. The guidelines were not developed for regulatory purposes, nor is strict compliance intended but rather they may be used as an arbitrary tool to assess the suitability of the water body for recreational use over an extended period of time.

Where a history of consistent or periodic failure is determined when compared to the NH&MRC guidelines, suitable signs should be erected advising bathers that the pool may not comply with the guidelines and that they should exercise discretion when bathing.

Each natural pool should be considered on its own merits by its controlling body. The controlling body should develop a plan of management to minimise and mitigate the effects of contamination. The plan of management could consider aspects such as:

- the incoming raw water quality,
- water distribution system to ensure that there are no dead spots,
- stormwater runoff diversion,
- installation of a skimmer to remove floating debris,
- pool turnover rates,
- maximum instantaneous bather,
- vacuuming, draining, scrubbing, and flushing,
- advice to bathers where the temperature exceeds 38 C limiting immersion to twenty minutes,
- patrons shall be required to toilet and shower before entry into the mineral pool, and
- warned patrons against head immersion due to the possibility of contracting primary amoebic meningitis,
- pool supervision while it is open to patrons.

The controlling body should consider aspects of public liability for health effects arising from the use of the pool.

Table 5: Test Methods for Bacteriological Criteria

Type of test	Test Method
Heterotrophic Colony Count	Pour plate method. Incubation for 48 hours at 35 C in accordance with Australian Standard Method AS4276.3.1 - 1995.
Thermotolerant coliforms	Australian Standard Method AS 4276.6 - 1995 (MPN Method) or AS 4276.7 - 1995 (Membrane Filtration Method).
Pseudomonas aeruginosa	Australian Standard Method AS 4276.12 - 1995 (MPN Method) or AS 4276.13 - 1995 (Membrane Filtration Method).

Table 6: Bacteriological Criteria

Type of Organism	Maximum Count Allowable
Heterotrophic Plate Count	100 Colony Forming Units (CFU) per mL.
Thermotolerant coliforms	Nil per 100 mL
Pseudomonas aeruginosa	Nil per 100 mL

ANNEXURE B1

CHLORINATION OF A PUBLIC SWIMMING POOL

Where water in a public swimming pool is being disinfected with a chlorine disinfectant it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1 The swimming pool water shall be disinfected using continuous dosing equipment.

2 The chemical parameters of the swimming pool water shall conform to Table 7:

Table 7: Chemical Requirements for Chlorinated Public Swimming Pools

Chemical Parameters for Pool Type					
Pool Type	Free Chlorine (mg/L) minimum	Total Chlorine (mg/L) maximum	Combined Chlorine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Outdoor	1.0	10.0	1.0	7.2 - 7.8	80 - 200
Outdoor stabilised with isocyanuric acid	3.0	10.0	Not Applicable	7.2 - 7.8	80 - 200
Indoor - temperature ≤ 26° C	1.5	10.0	1.0	7.2 - 7.8	80 - 200
Indoor - temperature ≥ 26° C	2.0	10.0	1.0	7.2 - 7.8	80 - 200

NOTE: Combined chlorine shall not exceed half the total chlorine concentration.

3 The maximum chlorine stabilising isocyanuric acid level in an outdoor pool is 100mg/L . No isocyanurate containing chemical shall be used in indoor swimming pools.

4 Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set to the equivalence of the minimum free chlorine concentration in Table 7 and shall no be less than 720mV.

5 Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 7.

6 Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE B2

BROMINATION OF A PUBLIC SWIMMING POOL

Where water in a public swimming pool is being disinfected with a bromine disinfectant it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1 The swimming pool water shall be disinfected using continuous dosing equipment.

2 The chemical parameters of the swimming pool water shall conform to Table 8:

Table 8: Chemical Requirements for Brominated Public Swimming Pool

Chemical Parameters for Pool Type				
Pool Type	Free Bromine (mg/L)minimum	Total Bromine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Outdoor	2.25	9.0	7.2 - 7.8	80 - 200
Indoor - temperature ≤ 26° C	3.5	9.0	7.2 - 7.8	80 - 200
Indoor - temperature ≥ 26° C	4.5	9.0	7.2 - 7.8	80 - 200

3 Where the sodium bromide plus hypochlorite process is used the minimum bromide concentration shall be 9 mg/L.

4 Where bromochlorodimethylhydantoin is used the maximum dimethylhydantoin concentration shall be 200 mg/L.

5 Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

6 Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set at the equivalence of the minimum free bromine concentration in Table 8 and shall be not less than 700mV.

7 Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 8.

8 Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE B3

OZONATION AND CHLORINATION OF A PUBLIC SWIMMING POOL

Where water in a public swimming pool is being disinfected with ozone and chlorine it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1. The swimming pool water shall be disinfected using continuous dosing equipment.

2. The ozone shall be generated by the corona discharge method and dosed in a closed system.

3. Residual excess ozone in the treated water shall be quenched with an activated carbon filter bed prior to the water being returned to the swimming pool.

4. Where **slipstream** ozonation is used (where 20% of the total water flow is ozonated) the chemical parameters of the pool water shall conform to Table 9:

Table 9: Chemical Requirements for Slipstream Ozonation and Chlorination of a Public Swimming Pool

Chemical Parameters for Pool Type					
Pool Type	Free Chlorine (mg/L) minimum	Total Chlorine (mg/L) maximum	Combined Chlorine (mg/L) maximum	PH range	Total Alkalinity (mg/L) range
Outdoor	1.0	10.0	1.0	7.2 - 7.8	80 - 200
Indoor - temperature ≤ 26° C	1.5	10.0	1.0	7.2 - 7.8	80 - 200
Indoor - temperature ≥ 26° C	2.0	10.0	1.0	7.2 - 7.8	80 - 200

NOTE: Combined chlorine shall also not exceed half the total chlorine concentration.

5. Where automatic dosing equipment using oxidation reduction potential (ORP) is installed in the sidestream ozonation process the ORP shall be set to the equivalence of the minimum free chlorine concentration in Table 9 and shall be not less than 750mV.

6 Reduced Chlorine Concentrations

6.1 Where mainstream ozonation is used the chemical parameters of the pool water shall conform with Table 10 (provided the chlorination dosing plant is capable of delivering the chlorine levels specified in Table 9 where ozonation fails):

6.2 Where automatic dosing equipment using redox potential (ORP) is installed in the mainstream ozonation process the ORP shall be set to the equivalence of the minimum free chlorine concentration in Table 10 and shall be not less than 720mV .

Table 10: Chemical Requirements for Mainstream Ozonation and Chlorination of Public Swimming Pools

Chemical Parameters for Pool Type					
Pool Type	Free Chlorine (mg/L) minimum	Total Chlorine (mg/L) maximum	Combined Chlorine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Outdoor	1.0	10.0	1.0	7.2 - 7.8	80 - 200
Indoor - temperature ≤ 26° C	1.0	10.0	1.0	7.2 - 7.8	80 - 200
Indoor - temperature ≥ 26° C	1.5	10.0	1.0	7.2 - 7.8	80 - 200

7. The contact time between the pool water and ozone shall be at least 2 minutes at an ozone concentration of 1mg/L with injection prior to filtration and 0.8mg/L with injection after filtration.

8. Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

9. Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Tables 9 and 10.

10. Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

OZONATION AND BROMINATION OF A PUBLIC SWIMMING POOL

Where water in a public swimming pool is being disinfected with ozone and bromine it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1. The swimming pool water shall be disinfected using continuous dosing equipment.

2. The ozone shall be generated by the corona discharge method and dosed in a closed system.

3. The chemical parameters of the swimming pool water shall conform to Table 11:

Table 11: Chemical Requirements for Ozonation and Bromination of a Public Swimming Pool

Chemical Parameters for Pool Type				
Pool Type	Free Bromine (mg/L) minimum	Total Bromine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Outdoor	2.25	9.0	7.2 - 7.8	80 - 200
Indoor - temperature ≤ 26° C	3.5	9.0	7.2 - 7.8	80 - 200
Indoor - temperature ≥ 26° C	4.5	9.0	7.2 - 7.8	80 - 200

4. The minimum calculated bromide concentration shall be 15 mg/L.

5. Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

6. Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set to the equivalence of the minimum free bromine concentration in Table 11 and shall be not less than 720mV.

7. The contact time between the pool water and ozone shall be at least 2 minutes at an ozone concentration of 2mg/L or sufficient to maintain the free bromine concentrations specified in Table 11.

8. Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 11.

9. A backup disinfection system shall be installed in the case of ozone plant failure.

10. Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE B5

POLYHEXAMETHYLENE BIGUANIDE (BAQUACIL®) AND HYDROGEN PEROXIDE

IN A PUBLIC SWIMMING POOL

Where water in a public swimming pool being disinfected with polyhexamethylene biguanide and hydrogen peroxide it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1 The disinfectant concentration shall be equal to or greater than 50 mg/L of polyhexamethylene biguanide in an aqueous solution, with 20% active ingredient.

2 The pool water shall be dosed at least once every 14 days with a shock dose of hydrogen peroxide to produce a concentration exceeding 100 mg/L of hydrogen peroxide in the pool water.

3 The pH shall be maintained within the range 7.2 to 7.8.

4 The total alkalinity shall be greater than 80 mg/L.

5 Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE C1

CHLORINATION OF A PUBLIC SPA POOL

Where water in a public spa pool is being disinfected with a chlorine disinfectant it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1. The spa pool water shall be disinfected using continuous dosing equipment.

2. The chemical parameters of the spa pool water shall conform to Table 12:

Table 12: Chemical Requirements for Chlorination of a Public Spa Pool

Chemical Parameters for Pool Type					
Pool Type	Free Chlorine (mg/L) minimum	Total Chlorine (mg/L) maximum	Combined Chlorine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Spa	2.0	10.0	1.0	7.2 - 7.8	80 - 200

3. Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

4. Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set to the equivalence of the free chlorine concentration in Table 12 and shall be not less than 750mV.

5. A notice shall be exhibited on the premises advising of the dangers of immersion in hot spa pools for longer than 20 minutes.

6. The water temperature shall not exceed 38 C.

7. Isocyanuric acid or isocyanurated compounds shall not be used as disinfection agents.

8. Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 12.

9. Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE C2

BROMINATION OF A PUBLIC SPA POOL

Where water in a public spa pool is being disinfected with a bromine disinfectant it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1. The spa pool water shall be disinfected using continuous dosing equipment.

2. The chemical parameters of the spa pool water shall conform to Table 13:

Table 13: Chemical Requirements for Bromination of a Public Spa Pool

Chemical Parameters for Pool Type				
Pool Type	Free Bromine (mg/L) minimum	Total Bromine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Spa	4.5	9.0	7.2 - 7.8	80 - 200

3. Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

4. Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set to the equivalence of the minimum free bromine concentration in Table 13 and shall not be less than 720mV.

5. A notice shall be exhibited on the premises advising of the dangers of immersion in hot spa pools for longer than 20 minutes.

6. The water temperature shall not exceed 38 C.

7. Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 13.

8. Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE C3

OZONATION AND CHLORINATION OF A PUBLIC SPA POOL

Where water in a public spa pool is being disinfected with ozone and chlorine it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1. The spa pool water shall be disinfected using continuous dosing equipment.

2. The ozone shall be generated by the corona discharge method and dosed in a closed system.

3. Residual excess ozone in the treated water shall be quenched with an activated carbon filter bed prior to the water being returned to the spa pool.

4. Where ozonation is used the chemical parameters of the pool water shall conform with Table 14:

Table 14: Chemical Requirements for Ozonation and Chlorination of a Public Spa Pool

Chemical Parameters for Pool Type					
Pool Type	Free Chlorine (mg/L) minimum	Total Chlorine (mg/L) maximum	Combined Chlorine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Spa	2.0	10.0	1.0	7.2 - 7.8	80 - 200

NOTE: Combined chlorine shall not exceed half the total chlorine concentration.

5 Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

6 Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set to the equivalence of the minimum free chlorine concentration in Table 14 and shall be not less than 750mV.

7 A notice shall be exhibited on the premises advising of the dangers of immersion in hot spa pools for longer than 20 minutes.

8 The water temperature shall not exceed 38 C.

9 Isocyanuric acid or isocyanurated compounds shall not be used as disinfection agents.

10 Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 14.

11 The contact time between the pool water and ozone shall be at least 2 minutes at an ozone concentration of 1 mg/l with injection prior to filtration and 0.8 mg/L with injection after filtration.

12 A backup disinfection system shall be installed in the case of ozone plant failure.

13 Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

OZONATION AND BROMINATION OF A PUBLIC SPA POOL

When water in a public spa pool is being disinfected with ozone and bromine it shall be maintained, when the pool is open for bathing, in accordance with the following parameters:

1. The spa pool water shall be disinfected using continuous dosing equipment.

2. The ozone shall be generated by the corona discharge method and dosed in a closed system.

3. The chemical parameters of the swimming pool water shall conform to Table 15:

Table 15: Chemical Requirements of Ozonation and Bromination of a Public Spa Pool

Chemical Parameters for Pool Type				
Pool Type	Free Bromine (mg/L) minimum	Total Bromine (mg/L) maximum	pH range	Total Alkalinity (mg/L) range
Spa	4.5	9.0	7.2 - 7.8	80 - 200

4. The minimum calculated bromide concentration shall be 15 mg/L.

5. Where automatic dosing equipment is installed it may control pH and disinfectant concentrations.

6. The contact time between the pool water and ozone shall be at least 2 minutes at an ozone concentration of 2 mg/L or sufficient to maintain the bromine level in Table 15.

7. Where automatic dosing equipment using oxidation reduction potential (ORP) is installed the ORP shall be set to the equivalence of the free bromine concentration in Table 15 and shall be not less than 720mV.

8. A notice shall be exhibited on the premises advising of the dangers of immersion in hot spa pools for longer than 20 minutes.

9. The water temperature shall not exceed 38 C.

10. A backup disinfection system shall be installed in the case of ozone plant failure.

11. Where automatic dosing using amperometric control is installed it shall be set to follow the requirements of Table 15.

12. Results of all chemical tests and the date and time of testing are to be entered into a log and kept onsite.

ANNEXURE D

DETERMINATION OF CHEMICAL WATER BALANCE

The Calcium Saturation Index can be used to determine chemical water balance from pH, total alkalinity and calcium hardness. In order to simplify the Calcium Saturation Index, a chart called the "Water Balance Chart" for temperatures of either 30 C or 40 C, has been devised and is attached. Other more versatile charts are available for purchase from some chemical suppliers and pool shops.

The water balance chart is divided into two scales where scale A is for water at 30 C and scale B is for water at 40 C. The total alkalinity scale is common to both scale A and scale B. For swimming pools scale A should be used and for spa pools use scale B.

Test the pool water for pH, total alkalinity and calcium hardness and then:

1 Plot calcium hardness on its scale first because it is the most difficult parameter to alter.

2 Plot total alkalinity because it is also a stable parameter.

3 Draw a line between the plots for calcium hardness and total alkalinity.

4 Note the pH from the chart.

5 Compare the chart pH to the measured pool pH.

a) If the pool pH is within 0.2 of the chart pH then the pool is balanced.

b) If the pool pH is greater than the chart pH by more than 0.2 then the pool has a positive imbalance and could cause scaling.

c) If the pool pH is less than the chart pH by more than 0.2 then the pool has a negative imbalance and is termed corrosive.

EXAMPLE

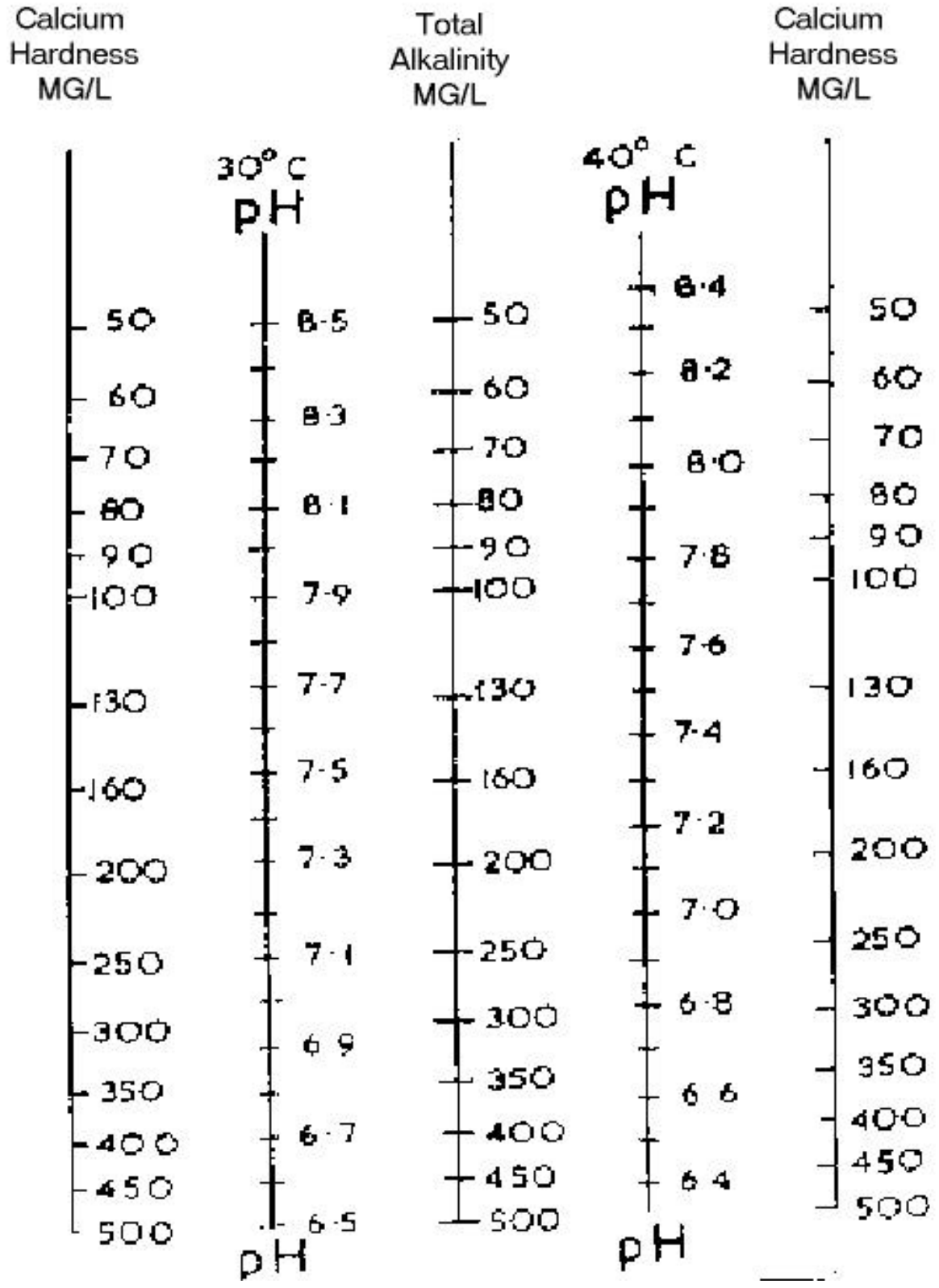
Consider a pool operated at 26 C and testing determines the results of

total alkalinity	: 160 mg/L
pH	: 8.0
calcium hardness	: 100 mg/L.

Solution:

Use scale A because the water temperature approximates 30 C. Plot both total alkalinity and calcium hardness, draw a line between the two plots and determine that the chart pH to achieve balanced water is 7.7. The actual pool pH 8.0 is higher than the chart pH by more than 0.2. Therefore in this case the pool is likely to be causing scaling and feel "hard" to bathers.

Water Balance Chart



Scale A Scale B