Ek-2 : Pool Standards, 2006 for the Swimming Pool, Wading Pool and Water Spray Park Regulations

I. Definitions and Interpretation

The following terms are defined in the Swimming Pool, Wading Pool and Water Spray Park Regulation and are repeated here for ease of reference.

(a) “bed and breakfast” means a private dwelling occupied by the owner or operator that offers overnight lodging and breakfast, but no other meal, for a fee, to no more than 8 registered guests at one time;

(b) “mV” means millivolt;

(c) “ORP” means Oxidation Reduction Potential;

(d) “pool” means a swimming pool, wading pool, water spray park and whirlpool;

(e) “Pool Standards” means the standards declared in force under section 2;

(f) “responsible person” means a person designated under section 3 as a responsible person;

(g) “swimming pool” means a structure containing a pool of water

(i) that is greater than 60 centimetres at its greatest depth, and

(ii) that is used for recreation, healing, therapy or other similar purpose and means all buildings and equipment used in connection with the structure but does not include

(iii) a swimming pool that is constructed for the use of a single family dwelling unit and used only by the owners and their guests, unless the structure is operated as a business, or

(iv) a swimming pool that is drained, cleaned and filled after each use by each individual;

(h) “wading pool” means a structure containing a pool of water that is 60 centimetres or less in depth throughout and is used for recreation or other similar purpose but does not include a wading pool that is constructed for the use of a single family dwelling unit and used only by the owners and their guests;

(i) “water spray park” means a structure onto which water is sprayed or released but does not accumulate and is used for recreation or other similar purpose and all buildings and equipment used in connection with it;

(j) “whirlpool” means a structure containing a pool of water that people enter that is designed primarily for therapeutic or recreational use and that

(i) is not drained, cleaned or filled before use by each individual, and

(ii) utilizes hydrojet circulation, air induction bubbles or hot water or any combination of them.

II. Purpose and Scope

The Pool Standards (Standards) are established under the authority of the Public Health Act ("Act") and the Swimming Pool, Wading Pool and Water Spray Park Regulation ("Regulation").

The primary objective of the Regulation and the Standards is to set out permit, operating and maintenance requirements for swimming pools, wading pools, water spray parks, whirlpools and any fountain or artificial pond that falls within the definition of a structure that constitutes a "pool", in accordance with the above definitions. The Regulation and Standards do not apply to flotation tanks or therapeutic pools which are used by one individual at a time and drained, cleaned and filled between each use, or to pools constructed for the use of a single family dwelling.

The requirements in the Regulation and Standards are based on current information and will evolve as technology changes. Important information regarding disinfection, chlorine resistant pathogens, filtration and recirculation is included. The goal is to enhance filtration, circulation and monitoring while maintaining a minimum but effective concentration of disinfectant to provide a safe swimming environment.

The Regulation and Standards set minimum standards for safe water quality and a safe and sanitary pool environment. These are minimum standards. Depending on the type of pool and use that a pool is put to; higher standards may be required. It is the responsibility of each pool owner to ensure optimum water quality and pool safety. Reference should also be made to the Alberta Building Code (ABC) for the specific requirements for pool construction.

III. Construction, Operation and Maintenance of Pools

1) Pool Operator Qualifications

1. A person who operates or maintains a pool must be trained in pool operation, water chemistry, pool filtration and maintenance.

2. Alberta Health and Wellness may:

a. identify qualifications, including upgrading requirements, that are required of a person who operates or maintains a pool (pool operator qualifications);

b. develop core elements and objectives for pool operation courses that will provide training for people who want to acquire pool operator qualifications;

c. review any existing pool operation courses that are submitted to the department to determine if the course provides for appropriate and cost effective training.

3. Stakeholders who may be consulted about pool operator qualifications and pool operation courses, include representatives of:

a. Regional Health Authorities,

b. Alberta Association of Recreation Facility Personnel,

c. Alberta Hotel and Lodging Association,

d. Alberta Pool and Hot Tub Association,

e. Alberta Lifesaving Society, and

f. other stakeholders as deemed necessary.

Practice Note:

Operating a pool facility has become progressively more complex with the increased use of water recreational facilities, the introduction of waterslides, water rides, wave pools, water spray play areas; the increased complexity of the pool equipment and treatment systems; and the emergence of chlorine resistant pathogens. Setting requirements for pool operator qualifications will ensure that all pools in the province are under the care and control of a person with a minimum level of training.

2) Filtration and Recirculation

1. A turnover period (referred to as recirculation) as required in Section 9 of the Regulation, must be no more than

a. 6 hours in all existing swimming pools. The turnover rate may be increased to 8 hours if an existing swimming pool is able to maintain water quality in the 8 hour turnover period, in accordance with microbiological standards in section 16 of the Regulation;

b. 2 hours for a stand alone recirculating wading pool or water spray park;

c. If a wading pool or water spray park is connected to a swimming pool, the applicable turnover rate for the swimming pool applies to the wading pool or water spray park;

d. 15 min for a whirlpool less than 4 cubic metres;

e. 20 min for a whirlpool of 4 or more cubic meters;

f. 4 hours for any new swimming pool constructed after the enactment of the Regulation or any swimming pool undergoing major renovations which affect the hydraulics of the system; and

g. 1.5 hours for a water slide receiving pool used solely for that purpose.

2. All recirculating pools must have a filter flow rate no greater than that specified by the manufacturer.

Practice Note:

The turnover rate for a new pool has been increased to 4 hours while existing pools can continue to operate at 8 hours provided that the required microbiological standards are being consistently met and maintained .

In pools with water quality issues, the dye test can provide an indication of the movement of water in the pool and any areas which are not well circulated. The test can also be a useful tool to check circulation patterns in a new facility or where renovations are being considered.

3. The accepted standard for effective recirculation is that eighty percent of the water must be circulated from the pool surface. The executive officer may allow pools to operate with a lower percentage of recirculation from the surface provided that the required microbiological standards are being consistently met and maintained.

Practice Note:

The highest concentration of organic pollution and contamination in a pool is found at or near the surface of the water irrespective of the mixing effects of the circulation. Therefore, recirculation of 50-80% of the water from the surface will produce a much healthier pool. (Pool Water Treatment Advisory Group 1999)

Each responsible person will need to evaluate the flow of the water and determine how to meet this requirement. The Alberta Building Code currently requires the circulation piping to accommodate 100% of the flow either through the skimmers or the drain, therefore, it may be possible to increase the flow from the skimmers or overflow channels without major changes to the system.

4. All filters must be backwashed and cleaned according to manufacturer instructions.

5. The rate of filtration must be no more than 15 gallons per minute per square foot (gpm/sq ft) for swimming pools and 12.5 gpm/ sq ft for whirlpools and the rate of backwash must not exceed the rate of filtration.

6. Pools using cartridge filters must have a second set of filters available to allow for adequate cleaning.

Practice Note:

The goal of these requirements is to produce satisfactory microbiological quality using the most effective filtration system in combination with minimum concentrations of chlorine residuals. Effective filtration will remove most of the organics and allow the chlorine to act on pathogens rather than the oxidation of organic material.

3) Disinfection

1. There must be no cyanuric acid (CYA) or stabilized products used in an indoor

pool. The concentration of CYA in an outdoor pool must not exceed 50 ppm. A higher concentration may be allowed only if the executive officer approves the higher concentration.

2. The concentration of cyanuric acid in an outdoor pool must be tested weekly.

Practice Note:

Cyanuric acid (CYA) is effective in reducing chlorine loss due to sunlight in outdoor pools. However, CYA does not degrade and even at 5 ppm of CYA, chlorine effectiveness can be reduced by 35%. There are diminishing returns with increasing concentrations. (Professional Pool Owner and Operators of America)

3. To assist in maintaining proper pH, the alkalinity must be maintained at 80-120 ppm and measured weekly. A higher concentration may be allowed in instances where an executive officer has provided approval.

Practice Note:

There are water sources throughout the province which have higher levels of alkalinity. In those cases, the responsible person must discuss the alkalinity level with executive officer and determine what steps are required in order to maintain the pH between 6.8 and 7.6.

The measure of total dissolved solids (TDS) is not included in this standard. TDS is closely related to the operation of the pool but is less important as a measure of pool water quality. Several authorities including the World Health Organization indicate that high TDS does not negatively compromise pool water quality.

4) Monitoring and Recordkeeping

1. Operating records must be maintained in a written form to provide information regarding:

a. quantities and dates of all chemicals used;

b. time and result of pH tests;

c. time and result of all free chlorine residual tests;

d. time and result of all combined chlorine residual tests;

e. results of microbiological analyses;

f. temperature of the water, recorded at least once every 24 hours; and

g. any other tests.

5) Microbiological Sampling

1. The pool water samples referred to in Section 15 must be taken:

a. from a point near an outlet and from any other locations that are necessary to give an accurate representation of the water in the pool; and

b. between 200 to 400 mm below the surface of the water. (Pool Water Treatment Advisory Group BSI Code of Practice 2003)

2. Samples of pool water must be submitted in sample bottles containing a dechlorinating agent, supplied by the Provincial Laboratory for Public Health (Microbiology).

3. The regional health authorities must forward the results of the samples to the responsible person for self-monitoring purposes.

Practice Note:

The results of routine microbiological sampling must always be interpreted in conjunction with:

• chemical tests performed on-site and/or in the laboratory at the time of sample collection; and

• a review of the maintenance records for the pool, including records of the pH, residual disinfectant levels, mechanical failures, water clarity and other related events.

Ongoing microbiological testing provides valuable trend data regarding the microbial quality of the pool water for both the health region and the operator. Both total coliform and heterotrophic plate count are indicators of disinfection efficacy and should be used to develop a baseline trend for each pool. All results, including Pseudomonas results, need to be interpreted in conjunction with pool chemistry records and the history of results.

6) Water Quality

1. The responsible person shall ensure that the maximum design bather load is not exceeded during the operation of the pool. Where the maximum bathing load has not been established, the following shall be met:

a. 1 person per square meter in a whirlpool; and

b. 1 person per 1.5 square meters in other swimming pools.

2. The responsible person may apply to the executive officer for an increase in bather load beyond the maximum design bather load specified in the design plans. The executive officer shall review the bather load as well as the overall swimming pool operation and if satisfied that pool water quality will be maintained, may allow the increase in bather load.

3. Where clarity problems persist, the executive officer may require monitoring of the turbidity using a meter until the turbidity is no greater than 0.5 Nephelometric Turbidity Units (NTU).

Practice Note:

Chemical parameters, turnover periods, turbidity, bacteriological results as opposed to bather ratios are the best indicators of water quality, particularly since each pool has varying capabilities to maintain pool water quality. Bather load is an historical guide that may help manage water clarity issues in some circumstances.

7) Anti-Entrapment

1. As required in Section 19 of the Regulation, pools with submerged suction outlets must be equipped with one of the following anti-entrapment devices:

a. A minimum of two outlets per pump with pipe centres at least 920 cm (3 feet) apart with covers listed, approved and installed in accordance with American Society of Mechanical Engineers (ASME) and American National Standards Institute (ANSI)/A112.19.8 performance requirements;

b. Anti-entrapment covers, on all suction outlets other than the skimmer(s), listed, approved and installed in accordance with ASME A112.19.8M performance requirements and flow through the drain grate which does not exceed 1.5 feet per second;

c. A Safety Vacuum Release System (SVRS) that relieves suction when a blockage is detected and that is installed to meet the performance standards of the ASTM International F2387 and/or ASME/ANSI A112.19.17s;

d. Drains which are at least 46 x 59 cm (18 by 23 inches) in size; (as based on torso size of 99th percentile male, weighing 244 pounds), or

e. If approved by the executive officer, alternative anti-entrapment devices or solutions may be implemented which:

i. comply with Guidelines for Entrapment Hazards: Making Pools and Spas Safer. United States Consumer Product Safety Commission March 2005, or

ii. are approved by a professional engineer.

2. The responsible person must ensure that all anti-entrapment devices are properly installed and in good working order.

3. The responsible persons must be able to demonstrate to the satisfaction of an executive officer that no entrapment or entanglement risk exists in the operation of a pool.

Practice Note:

This section is based on a minimum requirement to provide one "layer of protection" against entrapment or entanglement. The use of "one layer of protection" anti-entrapment devices requires ongoing monitoring and maintenance of that protection. The Guidelines for Entrapment Hazards: Making Pools and Spas Safer (United States Consumer Product Safety Commission March 2005) recommend an additional layer of protection in all swimming pools including whirlpools plus the installation of multiple drains and an SRVS back-up system in all wading pools. Every responsible person must determine whether an additional layer of protection is required for their pool.

IV. Written Policies

This section outlines the written policies every responsible person must have and implement under Section 20 of the Regulation. Policies must be appropriate for the type and number of pools that the policies cover.

1) Safety and Supervision Requirements

1. The responsible person must develop and implement a safety and supervision plan which sets out for each pool:

a. lifesaving equipment,

b. telephone access for emergencies,

c. a First Aid kit,

d. required bather to lifeguard ratios,

e. recommended bather safety for special events in any facility which does not provide life guarding, and

f. proper storage of pool treatment chemicals in compliance with the Alberta Fire Code.

Practice Note:

Information regarding lifesaving equipment and bather to lifeguard ratios can be found in the Lifesaving Society "Public Aquatic Facility Safety Standards 2004", "Semi-public Swimming Pool Safety Standards 2004" and "Public Wading Pool Safety Standards 2004".

The Alberta Building Code and the Alberta Association of Recreational Facility Personnel and the Lifesaving Society set out additional safety standards.

2) Notices for Public Safety

1. Each pool must have a sign(s) containing written information and, if possible, visual information, in a size and location that may be easily seen by all users, which directs or specifies:

a. Each bather must take a 'cleansing' shower prior to entering the pool.

b. No glass is allowed on the pool deck or in other barefoot areas.

c. Persons on medication for high blood pressure, heart condition or other medical conditions must to consult with a physician prior to use of the whirlpool or sauna.

d. No bather may be intoxicated while using the facility.

e. The pool depth and those areas where diving is not allowed.

f. The temperature range of the whirlpool, steam room and sauna.

g. Bather load and provides an explanation of why bather load is limited.

h. No pets are allowed onto the premises, except for seeing eye dogs or other animal used to assist persons with disabilities.

i. No street shoes may be worn in wet traffic areas.

j. Any other information that the responsible person determines is necessary to maintain the health and safety of the pool facility users.

2. In addition to Section 1, for those facilities where life guarding is not provided, signs must be provided directing or specifying that:

a. “Do not swim alone”,

b. “Children up to 14 years must be supervised”, and

c. “No lifeguard is on duty”.

3) Public Education

1. The responsible person must develop and implement a plan that is appropriate to the type of pool facility, for the education of bathers on the following:

a. Any person with diarrhea or a history of diarrhea over the previous 2 weeks must not use the pool facility,

b. Young children, 35 months and under, and anyone who is incontinent must wear protective, water-resistant swimwear in order to minimize the introduction of contamination,

c. Time in the whirlpool, sauna and steam room is to be limited to 10 minutes. Body temperature of children under 2 years rises very quickly and should be closely monitored to avoid cardiovascular effects. Pregnant women, persons with heart disease, hypertension, seizures, diabetes and obesity or those greater than 65 years of age should consult with their physician.

Practice Note:

With the increased concern regarding cryptosporidium, there is a greater need for young children and incontinent swimmers to wear water resistant swim wear. There does not appear to be truly waterproof swimwear on the market therefore, water resistant is the best choice available. Where possible, young children should be encouraged to swim in the teach/wading pool where any contamination can be isolated from the other pools (assuming there is an independent circulation system).

4) Water Quality Issues

1. The responsible person must develop and implement a response plan which outlines the steps to be taken when:

a. Standards for ORP, free chlorine, combined chlorine, cyanuric acid, pH and turbidity are not being met,

b. Blood, food or chemicals foul the pool, and

c. Fecal material or vomitus foul the pool. This plan must adhere to the requirements in Schedule A: “Fecal Contamination Management for Swimming Pools”.

2. The response plan must outline the persons responsible, emergency contact numbers, and the steps required to respond to each scenario.

5) General Sanitation Plan

1. The responsible person must develop and implement a plan which outlines a routine schedule for cleaning and adequate disinfection of:

a. pool decks;

b. washrooms and change rooms;

c. showers;

d. steam rooms and saunas; and

e. any other equipment in contact with users of the facility.

2. The plan must ensure that soap is provided in washrooms and showers.

Practice Note:

The pool facility must have a plan for ongoing cleaning and disinfection of all surfaces to minimize the transmission of pathogens. When considering flooring in dressing rooms, several studies indicate that the transmission of "athletes foot" is increased in those who swim regularly and that the floors in the facilities are a source of the fungi (Kamihama 1997, Attye, 1990). The best method of controlling transmission is the cleaning of floors, use of sandals and treatment of the disease. It follows that the floors must be made of surfaces which are impervious to moisture. The provision of soap and warm water at the showers will encourage bathers to shower prior to swimming.

V. Pool Premises

1. A shower must be equipped with a thermostatic mixing valve capable of providing water to each shower head with a temperature of 35°C to 40°C (refer to Section 7.33.29 of the Alberta Building Code)

2. Whirlpools must be fitted with temperature regulators.

3. A whirlpool must not operate at greater than 400 C (1040 F) while in use.

4. A steam room or sauna must be operated in accordance with manufacturers requirements in order to prevent excessive rise in body temperature when using these facilities.

5. The ventilation in all pool facilities must maintain safe air quality. Without limitation, the ventilation in all pool facilities must protect against the buildup of chlorine gas or other disinfection by-products.

6. A clock must be provided and clearly visible, adjacent to the whirlpool, sauna or steam room to assist bathers in determining the length of stay.

7. Any food handling and consumption must occur in a clearly designated area, set

aside for that purpose.

Schedule A

Fecal Contamination Management for Pools

Every responsible person is required to have and implement a written policy which outlines a response plan to managing fecal contamination in pools. This schedule has been developed to assist responsible persons by outlining the minimum requirements that their policy must contain.

1. Formed Stool

Solid fecal material is generally associated with healthy individuals and presents a low risk of transmitting microorganisms. It is also easily captured and removed from the pool. Should formed stool be found in a pool, the following steps must be taken:

a. Direct all bathers to leave the contaminated pool and close the pool to swimmers. To avoid cross-contamination, ask bathers to take a shower prior to re-entering any pool.

b. Shut off the recirculating pump and chemical feeders to slow down the dispersion of material through the water.

c. For those facilities with diatomaceous earth, continue to recirculate water to ensure exposure to the 2.0 ppm of chlorine.

d. Carefully remove as much of the fecal matter as possible using a net or scoop and dispose in a sanitary sewer. Vacuum the remaining particles and dispose vacuum contents to waste - not through the filter system. Thoroughly clean and disinfect any equipment used in this process. (100 parts per million chlorine solution)

e. If deck surfaces are contaminated, thoroughly clean and disinfect with a chlorine solution of 100 ppm.

f. Once cleaning is complete, turn on the recirculating pump.

g. Raise the free chlorine to 2.0 ppm throughout the pool and maintain for 30 minutes. Disinfectant concentrations must be measured at a minimum of three different locations in the pool. The pH must be maintained between 6.8 and 7.6 at all times.

h. Reopen the pool after the disinfection process and continue to maintain the free chlorine at operational levels.

Refer to "Inactivation of Viruses, Giardia and Cryptosporidium" in the reference section (p. 23).

2. Vomitus

There are few pathogens associated with vomitus. An exception is the Norovirus (previously known as Norwalk virus). However, Norovirus is more commonly spread through person to person contact rather than through pool water. To date, there is very little information on the inactivation of Norovirus in a pool setting. It is generally accepted that Norovirus is more resistant to chlorine disinfection than other viruses such as Hepatitis A.

The important steps in responding to vomitus in the pool are the physical removal of the organic material, followed by disinfection adequate to inactivate viruses.

Should vomitus be found in the pool, follow steps 1 - 7 for formed stool as listed above.

3. Liquid Stool (Diarrhea)

Liquid stool or diarrhea is associated with intestinal illness and often carries disease-causing micro-organisms. With the release of diarrhea into the pool, it must be assumed that there is a release of pathogens as well. Many gastrointestinal pathogens are sensitive to chlorine and are easily destroyed by normal operating concentrations of chlorine in the pool. However, the parasite Cryptosporidium, which is now known to be transmitted in pool water, is highly resistant to chlorine and may not be completely removed using standard rapid sand filtration or diatomaceous earth (DE) filtration. (refer to "Inactivation of Viruses, Giardia and Cryptosporidium" in the reference section (p. 23)). Since it is rarely known what microbe(s) is released by a swimmer, each incident of liquid fecal release must be treated as a potential release of Cryptosporidium and any treatment measures must be capable of inactivating the parasite.

If liquid stool (diarrhea) is found in the pool, the following steps must be taken:

I. Cleaning

a. Direct all bathers to leave the contaminated pool. Any pools connected through the circulation and filtration systems should be treated as if contaminated. Swimmers are required to take a shower prior to re-entering any other pools in the facility.

b. Shut off the recirculation pump and feeders to reduce the spread of contaminants in the water.

c. Carefully remove as much of the fecal matter as possible and dispose in sanitary sewer. Vacuum the remaining particles and the immediate areas. Any waste should be discharged into the sanitary sewer. The vacuum should be placed in the pool once the chlorination begins and flushed with the pool water for the duration of the treatment.

d. Thoroughly clean and disinfect deck surfaces as needed with a solution of 100 ppm chlorine.

e. Turn the recirculation pump and chemical feeders back on after cleaning is complete. Ensure that the filtration is operating at maximum efficiency during the disinfection process.

II. Disinfection

The current United States Center for Disease Control recommendation for responding to liquid stool is a Ct* of 9600 where C is the disinfectant concentration (in mg/l) and t is the time (in min.) This Ct will inactivate 99.9% (3 log removal) of Cryptosporidium oocysts in the pool. (MMWR May 25, 2001) This recommendation is based on the use of chlorine as the disinfectant and a long exposure period. Pathogens have varying sensitivity to chlorine and the Ct provides a quantitative number to indicate that sensitivity.

Some jurisdictions have suggested that a lower Ct value may be adequate but must be accompanied with other processes to minimize the infectious dose. In Britain, flocculation and coagulation, accompanied by filtration and six pool turnovers is required to achieve a 5 log removal. (Croll, 2002).

Log removal refers to an order of magnitude/inactivation of microbial organisms. 1 log removal = 90% removal, 2 log removal =99% removal, 3 log removal = 99.9% removal.

Given this current information and the limited scientific data available regarding the inactivation of oocysts in pool water, executive officers require a minimum 3 log removal to be reached when a liquid fecal incident occurs.

The most common disinfectant treatment method is chlorination, however, other methods could potentially be utilized, if prior approval has been received from the executive officer.

A. Disinfection with Chlorine

Where chlorination is used to treat the pool, the following steps must be followed:

a. Raise the free available chlorine residual to 20 ppm and maintain a pH of no more than 7.5 throughout the pool for 8 hours to provide a C(mg/l) x t(minutes) = 9600 at 25°C or greater. (also see: Equivalent Ct values for Chlorination at 25ºC)

b. Stabilized chlorine should not be used to raise chlorine concentration since it also introduces high levels of cyanuric acid into the pool. Concentrations of cyanuric acid greater than 50 ppm can interfere with the effectiveness of the chlorine.

c. Ensure that the chlorine concentration is found throughout all co-circulating pools by testing at a minimum of three widely spaced locations in each pool.

Note: Testing

A conventional chlorine test kit (DPD) can not be used to directly measure such high concentrations of chlorine but can be used if the pool water is diluted with non-chlorinated water and the results calculated. Testing can also be achieved by using the chlorine test strips commonly used in the food industry or a chlorine test kit with a broader testing range.

d. Run the circulation and filtration systems continuously during disinfection. Even without any coagulation/flocculation, rapid sand and DE filtration will provide some level of Cryptosporidium removal of microorganisms containing clusters and will promote mixing in pools.

e. Backwash the filter thoroughly after reaching the Ct value. All backwash water must be drained to waste. Where appropriate, change the filter media.

f. Where automatic systems are in place, the probes may need to be isolated and controllers placed on manual to override the automatic system.

g. Re-open the pool after the disinfection process is complete and the free available chlorine and pH are within acceptable operational range as required by the Swimming Pool, Wading Pool and Water Spray Park Regulation. (Chlorine levels in the pool may be reduced with sodium thiosulphate)

h. Pools with water features should chlorinate as described above, and flush the water features once the 20 ppm has been achieved.

i. Analysis of the water sample following the disinfection procedure is not required since Crypto is not routinely analysed in pool samples.

B) Disinfection with Supplemental Technology

Supplemental technologies such as ultraviolet disinfection (UV), ozone and chlorine dioxide, when properly applied, can effectively inactivate protozoans such as Cryptosporidium. Many of the new disinfectant processes have been used in drinking water treatment and their application to pool is not well understood.

Should a facility use a combination of chlorine and supplemental technology, the number of turnovers required will be determined by the regional health authority in order to achieve an equivalent Ct of 9600.

4. Low Volume Pools - Whirlpools and Wading Pools

If low volume pools such as a whirlpools, teach pools or wading pools are contaminated with loose stool, the fecal matter must be removed, the pool drained and the pool basin cleaned and disinfected.

After cleaning, the pool basin should be disinfected with a 100 ppm chlorine solution (6.7 ml of 5.25% bleach in 1 gallon water). The water should be recirculated for 2 full turnovers in order to ensure that all parts of the system are superchlorinated. A recirculating type pool should be refilled and then re-opened when free chlorine levels and pH are within acceptable operational range as specified by the Regulation. Flow-through pools may resume operation following disinfection of the pool basin.

5. Recordkeeping and Notification

All fecal accidents must be recorded in a log book describing the date, time of the event, type of incident, concentration of free available chlorine and ORP at the time, pH, procedures followed and the person(s) conducting the procedures.

Any release of liquid fecal material into a pool should be reported to the regional health authority within 24 hours.

Reference Materials

A. Approval Process for Ultraviolet (UV) Treatment

The following protocol provides a reference for regional health authorities regarding the application of ultraviolet technology in response to fecal contamination and the steps required to evaluate and approve its use in a pool. (EPCOR, County of Strathcona, 2002)

The steps required to certify a pool prior to using UV are to:

a. Measure and evaluate water quality

b. Conduct dye and/or mixing study of pool

c. Determine turnovers needed to respond to fecal contamination

d. Install an approved UV system

e. Follow protocol to operate UV system

1. Measure and Evaluate Water Quality

Transmittance describes the extent to which radiation is able to pass through the water. Transmittance, which is affected by organics in the pool, is a key parameter that will determine whether a UV system will be effective in a particular pool.The United States Environmental Protection Agency indicates that 95% transmittance reflects an excellent source of water, 85% transmittance reflects "good" source and 75% transmittance is a "fair" source of water. If below 80% transmittance, the design of the lamps becomes more complex and more UV lamps may be required.

2. Conduct Dye and/or Mixing Study of Pool

Since the UV reactor is installed in the pool piping system (after the pool filters), a mixing study must be done on the pool to ensure that there are no dead zones in the pool basin and that 99% of pool water goes through the filter over the specified number of turnovers. If there are dead zones, any contaminants in these zones will not pass through the UV unit in an acceptable time period. A mixing study should be conducted in two phases - a dye test and a tracer study. A dye test is a visual test while a tracer test provides quantitative results.

Dye Test

An initial dye test will identify circulation patterns in the pool. To pass the test, the entire body of water should change to a fully dispersed dye color within 20 minutes. If unsuccessful, the circulation system should be modified and the pool retested prior to any further steps.

Tracer Study

A tracer study provides more precise information regarding the mixing and circulation of the pool water. It determines how long it takes for water to turn over in the pool using a standard methodology from the water industry. It measures the length of time required for a tracer chemical to fully mix into the pool and reach full equilibrium after reaching the filters. The results are interpreted on a pool by pool basis.

3. Turnovers Needed to Respond to Fecal Contamination

UV can achieve a 3-log removal of Cryptosporidium at an applied dose of 20 mJ/cm2. If a pool is demonstrated to be properly mixed, a properly applied UV system has the ability to make the pool safe in 4 to 6 pool turnovers.

Based on the mixing study, the number of pool turnovers required to reduce Cryptosporidium levels in the pool to a safe level (no more than 1 oocyst/10 litres of water) can be determined. If the pool is well mixed it has been estimated that 99.7% of the water will have passed through the UV system in 4 pool turnovers, 99.95% in 5 pool turnovers and 99.99% in 6 pool turnovers. Depending on the volume of the pool and estimated contamination level, between 4 to 6 turnovers can reduce the Cryptosporidium to a safe level. The actual number of turnovers will have to be demonstrated to and approved by the regional health authority on a pool by pool basis.

4. Install an Approved UV System

An in-line UV disinfection system with full stream - 100% pass system with no side or slip stream must be used in pools. The following components are required for an approved UV system:

Reactor Validation: Reactors must be validated by bio-assay to ensure that the geometry and configuration of the reactor can provide the dose listed by the manufacturer.

Design Dose: A minimum dose of 20 mJ/cm2 is required for the poorest predicted water quality.

Sensors: Reactors must have sensors to ensure that the required dose of UV light is being met. The sensors can be used to confirm and adjust the dose as required, and indicate when to change lamps or clean the quartz sleeves.

Monitoring / Alarming: A control system should be included with the UV unit that provides information on the UV operation to be historically recorded. This system should also give alarms, notifying the pool owner or responsible persons that a breakdown has occurred or some maintenance is required.

5. Follow Protocol to Operate UV System

The lamps and their quartz sleeves in the ultraviolet system require periodic attention to maintain efficient operation. Daily checks of the control system are required to ensure that the UV unit is operating within parameters.

B. Inactivation of Viruses, Giardia and Cryptosporidium

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January 2003

Viruses :

The resistance of pathogens to chlorine can be described by determining their respective Ct values. However, there are few studies on viral inactivation and these were conducted at lower temperatures, with different water matrix conditions. The following table provides some guidance as to the resistance of these viruses

Virus	Water type	Temp (°C)	pH	Ct	Log Removal
Rotavirus	Wastewater	15	7,2	20,5	< 1
Rotavirus	Buffered water	4	7,0	0,03	5
Poliovirus	Buffered water	25	7,1	1	3,5
Hepatitis A	Buffered water	25	7,5	0,6	4

Giardia :

Much more work has been done on Giardia and published by Alberta Environment in "Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems". These inactivation standards have been adopted by Alberta Environment in their “Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (1997).

pH	Temp (°C)	Ct 3 log Inactivation*
7,0	25	46
7,5	25	55
8,0	25	67

**A safety factor of 1.5 was applied by US EPA and adopted by Alberta Environment*

Based on this information, a Ct of 60, as required in this standard for low risk incidents of formed stool, would be adequate to inactivate Giardia in the pool.

Cryptosporidium :

Although more research is needed on the resistance of Cryptosporidium in a pool

pH	Temp (°C)	Ct 2 log Inactivation	Ct 3 log Inactivation
6,0	22	5,500	12,300
7,0	22	6,800	15,100
7,5	22	9,800	22,000
8,0	22	19,000	43,300

setting, the paper by Gyürek, ***L.L., Finch, G.R. and Belosevic, M. (1997) provides the following information of extrapolated results from their predictive inactivation model:***

Further experimental work indicates that for Cryptospo-ridium, a Ct of 9600 may pro-vide a 3 log removal at 25ºC and pH 7.5 with filtration providing 0.5 log inactivation per pass of water.

Characteristics of Cryptosporidium :

Cryptosporidium hominus previously known as C. parvum human genotype 1 are protozoan gastrointestinal parasites causing diarrhea, vomiting, nausea and in some cases, abdominal pain. It is associated with humans, as well as cattle and other domestic animals.

The parasite is transmitted through the fecal-oral route. During an infection, oocysts are produced and released in the feces. The oocysts are highly resistant to chlorine and are excreted at the onset of symptoms and several weeks after symptoms resolve. In a moist environment, they may remain infectious for 2-6 months.

Recent studies have demonstrated that as few as 10 oocysts can cause infection in humans.

A 1999 survey of Giardia and Cryptosproidium in formed stools demonstrated that formed stools do not appear to contain Cryptosporidium, whereas 4.4% were shown to be positive for Giardia (MMWR, May 25,2001). These results confirm a low prevalence of Cryptosporidium within formed stools. Current requirements for removal of formed stool and pool treatment are adequate to inactivate Giardia and other known viral and bacterial pathogens.

In addition to its chlorine resistance, the Cryptosporidium oocyst is 4-6um in diameter, making it too small to be removed completely by standard rapid sand filtration or diatomaceous earth. In England, studies have shown that with enhanced filtration using a low filter rate and efficient coagulation, a 3 log removal can be achieved. (Gregory, 2002) In Alberta, the drinking water standards give only a 2 log credit for filtration with optimized coagulation, filtration, flocculation and settling. Therefore, one more log credit would be needed to remove cryptosporidium. Inactivation of oocysts by ozone, ultraviolet radiation or chlorine dioxide has also proven to be effective.

C. Equivalent Ct Values for Chlorination at 25°C*

- At higher temperatures the effectiveness of the chlorine is enhanced.
- Ct values must be doubled for each 10°C drop in temperature.
- 10 mg/l is the lowest concentration of chlorine used in research and it is

difficult to extrapolate to concentrations below that.

- "Concentration" used in this table is the residual at the end of the specified contact time – not the dose applied or the average residual.

Chlorine Concentration (C mg/l)	**pH**	**time (min)**	**time (hours)**	**C**(mg/l)x**t**(min)
10 mg/l (minimum concentration allowed)	7,5	960	16	9600
15 mg/l	7,5	640	10,6	9600
20 mg/l	7,5	480	8	9600
25 mg/l	7,5	384	6,4	9600
40 mg/l	7,5	240	4	9600
80 mg/l	7,5	120	2	9600

Ek-3 : Management of Spa Pools Controlling the Risks of Infection

Background to the control of infectious agents in spa pools

What is a spa pool?

1. A spa pool is a self-contained body of warm, agitated water designed for sitting in - see section 1.1.2 for further definitions.

Why do we need this guidance?

2. Infectious agents can be easily introduced to a spa pool via bathers, from dirt entering the pool or from the water source itself. Once in the spa pool, conditions often exist for these infectious agents to grow and proliferate. There have been several examples of people contracting infections from spa pools, for example Legionnaires disease, and in all known cases the spa pools were not being managed as required by existing health and safety regulations and guidelines. This guidance has been written to help managers , designers and manufacturers of spa pools meet their legal duties under health and safety legislation.

Which infectious agents grow in spa pools?

3. The bacteria that cause Legionnaires disease frequently grow in poorly designed and managed spa pools. Other bacteria commonly found in spa pools, which can cause infection, are Pseudomonas aeruginosa and environmental mycobacteria. More information on the hazards associated with spa pools can be found in Section 1.1.

Why are people using or working near spa pools at risk of contracting an infection from the spa pool?

4. Spa pools are designed to contain water that is vigorously agitated and this leads to the formation of aerosols that can be inhaled. This means even people not in the immediate vicinity of the spa pool can breathe in the aerosol. This is particularly important with Legionella. In outbreaks, research showed that Legionella antibody levels were higher in individuals who were closer to the source of the contamination1. People using the spa pool are also at risk from skin infections because prolonged immersion in warm water increases the likelihood of infectious agents entering the body via the skin.

Legislation - health and safety, and other relevant law

Introduction

5. The Health and Safety at Work etc Act 1974 (HSWA) 2, the Management of Health and Safety at Work Regulations 1999 (MHSWR)3 and the Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH)[4] impose certain statutory duties on all managers of non-domestic spa pools. Duties under the HSWA extend to risks from infectious agents arising from work activities, ie risks to non-employees. The MHSWR provide a broad framework for controlling health and safety at work. COSHH provides a framework aimed at controlling the risks from hazardous substances including infectious agents.

Duties under Section 3 of the HSWA

6. If people working under the control and direction of others are treated as self-employed for tax and national insurance purposes, they are nevertheless treated as employees for health and safety purposes. It may, therefore, be necessary to take appropriate action to protect them. If any doubt exists about who is responsible for the health and safety of a worker, this could be clarified and included in the terms of a contract. However, a legal duty under Section 3 of HSWA cannot be passed on by means of a contract and there will still be duties towards others under Section 3 of HSWA. If such workers are employed on the basis that they are responsible for their own health and safety, legal advice should be sought before doing so.

Management of Health and Safety at Work Regulations 1999

7. Under these Regulations the manager of a spa pool is required to

- assess the risks in their workplace,
- use competent help to apply health and safety legislation,
- establish procedures to use if an employee is presented with serious and imminent danger, and
- co-operate and co-ordinate health and safety if there is more than one employer in a workplace.

Control of Substances Hazardous to Health Regulations 2002 (as amended)

8. Under COSHH the manager is required to

- assess the risks of exposure to hazardous substances in their workplace,
- prevent exposure or substitute with a less hazardous substance or process/method if possible,
- control exposure if prevention or substitution are not reasonably practicable,
- maintain, examine and test the control measures, eg automatic dosing systems,
- provide information, instruction and training for their employees, and
- provide health surveillance of employees if appropriate.

9. More information on COSHH in general can be found in the COSHH Approved Code of Practice (ACoP)4 and on Legionella in Legionnaires disease: The control of legionella bacteria in water systems ACoP5 (L8).

10. L8 gives practical advice on the requirements of the HSWA, MHSWR and COSHH concerning the risk from exposure to Legionella bacteria. This ACoP applies to employers in control of premises where Legionella bacteria could be found, and also sets out the responsibilities of suppliers of services such as water treatment, as well as those of manufacturers, importers, suppliers and installers. L8 gives guidance and practical advice on identifying and assessing the risk, managing the risk and record keeping; with detailed guidance on managing cooling towers, and hot and cold water services, along with some information on other risk systems, eg spa pools, humidifiers, car washes. Although only a court can give an authoritative interpretation of the law when considering the application of health and safety legislation, HSE and Local Authority inspectors expect employers to follow the guidance in the ACoP or be able to demonstrate that their alternative procedures/processes provide an equivalent level of protection. The information and advice provided in *Management of Spa Pools: Controlling the Risks of Infection* is intended to help managers, designers, manufacturers etc meet the legal requirements explained in L8 in the context of spa pools.

Enforcement

11. Enforcement of health and safety legislation falls to two bodies, the Health and Safety Executive and Local Authorities (LAs). The HSE are responsible for enforcement with respect to designers, manufacturers and installers and for spa pools in premises where HSE is the enforcing authority eg government buildings, factories. LAs are responsible for enforcement in hotels, retail outlets, and private sports and fitness clubs. The majority of commercial spa pools will be under the enforcement of Local Authorities. Both HSE and LA inspectors will expect employers to meet their legal responsibilities as explained in the COSHH ACoP4 and L85. Each LA will make their own arrangements for inspections and water quality monitoring.

12. The enforcing authorities have the power to close a spa pool (Prohibition Notice) if there is an imminent risk to health. They can also require improvements (Improvement Notice) where the management of a spa pool is falling below legal standards.

The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)6.

13. These Regulations require employers and others to report accidents and some diseases arising out of or in connection with work to the Health and Safety Executive. For example, certain case(s) of Legionnaires disease are reportable under RIDDOR. Further information on RIDDOR can be found in HSE guidance7 or on the HSE website at http://www.riddor.gov.uk

The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP)

14. These Regulations require suppliers of chemicals to

- identify the hazards of the chemicals they supply;
- give information about these chemicals; and
- package the chemicals safely.

The supplier must do this using labels 8,9 and safety data sheets10.

The Construction, Design and Management (CDM) Regulations 1994 (as amended)

15. The CDM Regulations require that health and safety is taken into account and managed throughout all stages of a project, from conception, design and planning through to site work and subsequent maintenance and repair of the structure. These regulations apply to most common building, civil engineering and engineering construction work (including demolition, dismantling and refurbishment). Clients and designers have specific duties under the regulations. Further information on health and safety during construction can be obtained from the HSE website (http://www.hse.gov.uk/construction/) where there is information on these regulations and references to relevant leaflets and guidance.

The Biocidal Products Regulations 2001 (BPR)11

16. BPR aims to ensure all biocidal products on sale are safe when used properly. Biocidal products are any chemicals intended to control unwanted organisms, including bacteria, viruses and fungi; public health disinfectants are classed as biocidal products. It is important the manager follows the classification and labelling information on a biocide product's packaging. There will be clear instructions on how to use it safely. Under the BPR the manager has a legal responsibility to use the correct product for the job and to use it properly. Further information for the users of biocidal products can be found in the HSE guidance A guide to the *Biocidal Products Regulations for users* of biocidal products12.

Water Supply (Water Fittings) Regulations 199913 and Water Byelaws 2004 (Scotland)14

17. This legislation is intended to prevent contamination, waste, misuse, undue consumption and erroneous measurement of water supplied by the water undertaker. It imposes requirements on the plumbing system, water fittings, and on appliances connected to it or receiving water from it. Guidance on following this legislation can be found in the Water Regulations Guide15 published by the Water Regulations Advisory Scheme (WRAS), and on the Defra website (http://www.defra.gov.uk/ environment/water/industry/wsregs99/ guide/index.htm).

Liabilities and workmanship

18. Under Section 73 of the Water Industry Act 199916, as well as Regulations 3 and 4 of the Water Supply (Water Fittings) Regulations [in England and Wales] and Water Byelaws (Scotland), responsibilities and liabilities are set out on managers and owners to ensure that water installations comply with requirements in the Regulations. These particularly apply to the suitability of the water fittings and appliances, the quality of workmanship, the maintenance of fittings in good order, and that water supplies are not contaminated.

Consumer legislation

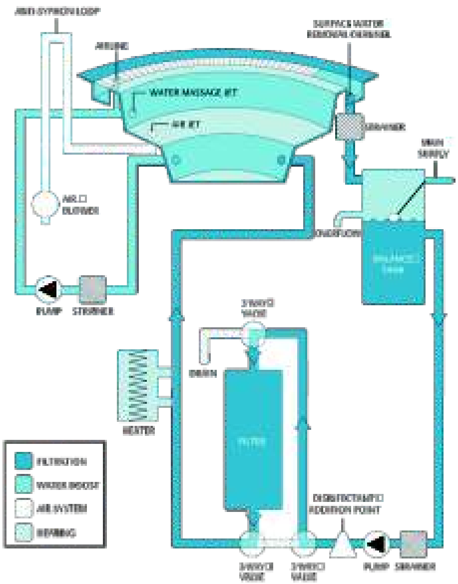
19. Under the Consumer Protection Act 198717 consumers have the right to expect their purchased spa pool to

• be of satisfactory quality, ie of a quality that a reasonable person would expect given the description, price and other relevant circumstances;

• be fit for purpose, ie it can be used for the purpose expected; and

• match its description (verbal or written), and if the spa pool is chosen after seeing a sample it must match this. (It is a criminal offence for a trader to put a false description on goods.)

20. Further information on consumer rights can be obtained from the Department of Trade and Industry (Dti) at www.consumerdirect.gov.uk, in the Dti's guide to the Consumer Protection Act (available via their website www.dti.gov.uk) called *Guide to Consumer Protection Act 198718*, from Trading Standards www.tradingstandards.gov.uk), and from the European Consumer Centre at www.euroconsumer.org.uk (if the trader is based outside the UK but elsewhere in the European Union).



Part 1

Regulatory Requirements

1.1 Scope and application

1.1.1 Who is this guidance aimed at

21. This guidance is intended to help people **who manage and/or operate spa pools** to control the risks from infection to their staff, the users, and anyone else potentially exposed to the spa pool water or aerosols from it. However, it should also provide useful advice for the following groups of people:

designers; architects; manufacturers; suppliers; installers; maintenance staff; consultants; environmental health officers; cruise ship operators; tour operators; domestic owners; rental companies;

and

organisers of events where spa pools are displayed

1.1.2 Definition of a spa pool

22. A spa pool is designed for sitting or lying in up to the neck, and not for swimming. It is a self-contained body of water that is filtered and chemically disinfected. A spa pool is not drained, cleaned or refilled after each user, but after a number of users or a maximum period of time. Spa pools contain water heated to 30¡C to 40¡C, and have hydrotherapy jet circulation with or without air induction bubbles. Spa pools can be sited in- or outdoors. Common terms for spa pools are hot spa, hot tub, whirlpool spa and portable spa. Jacuzzi¨ is the registered trade name of a specific manufacturer and should not be mistaken for a generic name for spa pools.

1.1.2.1 Commercial spa pools

23. A commercial spa pool is an overflow/level deck spa pool installed in a commercial establishment or public building, and generally used by people visiting the premises. Typical sites for commercial spa pools include hotels, health clubs, beauty salons, gymnasia, sports centres and clubs, swimming pool complexes, and holiday camps. A spa pool in such a location is considered commercial even if payment for use is not required. A domestic spa pool installed in a hotel bedroom or holiday home should also be managed as a commercial spa pool. Similarly spa pools rented out to domestic dwellings for parties etc must also be considered commercial.

Commercial spa pool

Whirlpool bath

Swim spa

Domestic spa

1.1.2.2 Domestic spa pools

24. A domestic spa pool or hot tub is a freeboard or overflow/level deck spa pool installed at a private residence, for the use of the owner, family and occasional invited guests.

1.1.2.3 Whirlpool baths

25. Whirlpool baths are typically found in beauty parlours, health suites, hotels and dwellings. Water within the bath is untreated and the bath is drained following each session. Whirlpool baths have experienced similar problems to spa pools with the formation of biofilms within the pipework system associated with the air and water booster jets, so regular disinfection is recommended.

1.1.2.4 Swim-spa

26. A swim- or fitness-spa is a small combined swimming pool with hydrotherapy jets, air induction and counter-current exercise unit; or joined swimming pool and spa pool compartments. Such installations can be for residential or light commercial use. Bather loads and water temperature will not be as high as in spa pools.

1.1.3 Other equipment not covered by this guidance

27. The equipment not covered by this guidance includes

• swimming pools19,

• hydrotherapy pools20,

• foot spas, and

• flotation tanks.

1.1.4 Microbiological hazards

28. A variety of infectious agents are associated with the recreational use of water and these can affect the skin, ears, eyes, gastrointestinal and respiratory tracts. However, most spa pool users do not immerse their heads in the water (and are strongly advised not to do so), so there are relatively few reported outbreaks associated with ear, eye or gastrointestinal tract infections.

29. Spa pools are much smaller than swimming pools and have a much higher ratio of bathers to water volume, so the amount of organic material in spa pools is far higher than in swimming pool water. These conditions can allow pathogens such as Pseudomonas aeruginosa and Legionella species to readily grow in spa pools. Water disinfection is, therefore, a key control measure, but the raised temperature and high organic content of spa pool water can make it difficult to maintain effective disinfection.

1.1.4.1 Legionella species

30. Legionella infection can present as a respiratory infection called Legionnaires disease or a self-limiting flu-like illness called Pontiac fever or sometimes Lochgoilhead fever. There have been a number of outbreaks linked to spa pools,

including those

- in leisure centres21,
- in hotels 22,
- in holiday homes23,
- on cruise ships 24, and
- on display25.

Experience has shown that those most at risk from infection are smokers, men, people over 50 years old, as well as immunocompromised individuals (see HPA website http://www.hpa.org.uk/ infections/topics_az/legionella/menu for further information).

• An outbreak in 1984, associated with a spa pool in a hotel in Saltdean, Sussex, caused 23 cases of LegionnairesÕ disease.

• An outbreak in Lochgoilhead, Scotland of acute Pontiac fever affected 170 people.

• Within four days of their installation one or both of two new spa pools on display at a Netherlands flower show were the source of one of the worldÕs largest outbreaks of Legionnaires disease in 1999. There were 188 (133 laboratory confirmed) cases and 21 deaths. People pausing at the spa pools had an increased chance of developing the disease.

• Again in 1999 an outbreak of Legionnaires disease was considered to be due to demonstration hot tubs at a Belgian fair. Stand employees, technical staff and visitors were amongst the 93 cases and 5 deaths.

1.1.4.2 Pseudomonas aeruginosa

31. There have been numerous outbreaks of folliculitis caused by P. aeruginosa associated with spa pools and hot tubs26. The folliculitis presents as a red rash and involves infection of the hair follicles. Disease is related to the duration of spa pool immersion as well as the degree of contamination of the water, and children and young adults are most susceptible.

1.1.4.3 Mycobacterium avium and similar Mycobacteria

32. Mycobacterium species are common in water and some of them are important respiratory pathogens. Respiratory disease has been associated with non-tuberculous mycobacteria, particularly Mycobacterium avium, in association with spa pools and hot tubs27.

1.1.4.4 Amoebae

33. Naegleria fowleri, an amoeba found in warm water, is a rare cause of fatal meningitis that has been associated with natural spas. Acanthamoeba species are common in water, including swimming pools, where they normally graze on bacteria. They can cause keratitis, a severe eye infection particularly associated with contact

lens wearing; this can lead to loss of sight. This amoeba can also cause encephalitis, an infection of the brain.

1.1.4.5 Other potential infections

34. The gastrointestinal infections associated with swimming pools might also be expected to be potential infections from spa pool use. However, since users do not normally ingest spa pool water the chance of transmission of enteric infections is much reduced.However, exceptions have occurred, particularly when behaviour was abnormal. Thus an outbreak of Hepatitis A affected seventeen young men using a spa pool, although infection appeared to be caused by head immersion and 'whale spitting'28.

35. Cryptosporidium infections have been associated with swimming pools. Cryptosporidiosis is a particular problem in swimming pools because it is resistant to chlorine. Cryptosporidium infection is especially dangerous for people infected with HIV. In a US study the serological response to Cryptosporidiosis as a marker of infection was associated with spa pool use29 but infection appeared to be associated with sexual activities in the spa pool rather than from ingesting water.

36. It has been suggested that Herpes virus might survive within the spa pool environment and cause infections30 but there is little evidence that this occurs in practice. Normal disinfection regimes should prevent survival of the virus in a spa pool.

37. Other infections have been associated with using spa pools but in reality were probably transmitted by other means in the changing rooms, eg furunculosis caused by Staphylococcus aureus31 and molluscum contagiosum (a viral skin infection producing papillomas).

1.1.4.6 Natural spas

38. The hazards associated with the use of natural spas are essentially the same as artificial spa pools.

1.1.5 Non-microbiological hazards

39. This guidance does not give detailed advice on how to manage the risks associated with non-microbiological hazards in the workplace. However, managers need to be aware that other hazards do exist and will need to be managed. A few of these are highlighted below with, where appropriate, references to other documents that will give further advice on how to manage them.

40. For users, the most immediate danger arises from accidental drowning, but they may also risk slipping or tripping, and getting caught in fittings such as the outlets. An analysis of deaths linked to spa pools and saunas in the US found 151 deaths related to spa pool use and only 7 to saunas. Children under 12 years old were involved in 6 out of the 151 deaths32. The chief risk factors were

- alcohol ingestion (38%),

• heart disease (31%),

• seizure disorders, eg epilepsy (17%), and

• cocaine and alcohol abuse (14%).

Accidental drowning in uncovered or improperly covered spa pools and, to a lesser extent, entrapment by suction, were the chief causes of childhood drowning. Shortening the time of exposure, lowering the water temperature, and using warning notices are options to help prevent deaths.

1.1.5.1 Chemical

41. The Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended) cover hazardous chemicals as well as infectious agents. The risks associated with working with the chemicals used in a spa pool also need to be managed. Further guidance on managing such risks can be found in the COSHH Approved Code of Practice4 and on the COSHH Essentials website (http://www.coshh-essentials.org.uk/).

1.1.5.2 Thermal

42. Thermal hazard will generally be an issue for users rather than people working near or passing by a spa pool. Animal experiments suggest that prolonged immersion in water above body temperature can lead to delayed shock33, and also lead to adverse effects on the foetus in pregnancy34. It is therefore important to note that the warm temperature of spa pools could pose a risk of ill health to users who are pregnant, have cardiovascular problems, or are subject to fits. People taking medication for cardiovascular and nervous system conditions, and those with physical disabilities35 should seek medical advice before using a spa pool.

43. It is possible that the high temperature and humidity around the spa pool could affect people working for long periods close to it.

1.1.5.3 Electrical

44. Standards covering the installation of swimming pools and spa pools were introduced in 1992 and updated in 2001 and 2004 (BS 7671:200136). For spa pools used by the public the Electricity at Work Regulations 198937 will also need to be complied with. Further information on the standards can be obtained from the Institution of Electrical Engineers (IEE); the IEE also sell the standards. Further information on the risk of working with electrical equipment can be found on the HSE website (www.hse.gov.uk) and in the free leaflets 5 steps to risk assessment38 and Electrical safety and you39.

1.1.5.4 Slips and trips

45. A slip or trip accident happens every three minutes in the workplace to employees or members of the public; they are the most common causes of major injuries at work. Water in and around the spa pool will present a slip hazard for users and those walking close to the equipment. Obstructions around the spa pool could

present a trip hazard. The spa pool manager is legally required to assess the risk of slips or trips under health and safety law. HSE publishes advice on managing the risks of slips and trips in the free leaflet Preventing slips and trips at work40 and the priced book Slips and trips: Guidance for employers on identifying hazards and controlling risks41. Information on designing spa pools to minimise slip and trip hazards can be found in the SPATA Standards42.

1.1.5.5 Confined spaces

46. Care must be taken if working in confined spaces, for example in/around the balance tank. Work in the space may also be risky due to the difficulties in getting emergency help into the space. Ideally the spa pool area should be designed to ensure there are no confined spaces.

47. The risk of working in a confined space must be assessed under the Management of Health and Safety at Work Regulations 19993 and the Confined Spaces Regulations 199743 may also apply. Further information on assessing the risk of working in confined spaces can be found in the free leaflet Safe work in confined spaces44 and the Approved Code of Practice Safe work in confined spaces45.

1.1.5.6 Manual handling

48. Care must be taken when handling heavy and/or awkward loads to avoid manual handling injuries. Such injuries can lead to cumulative damage that can be severe and debilitating. The Manual Handling Operations Regulations 199246 (as amended in 2002) require the spa pool manager to avoid manual handling operations if it is reasonably practicable to do so. If it is not reasonably practicable, they must carry out a manual handling assessment. Further information can be found in the guidance on the Regulations47 and Getting to grips with manual handling - a short guide48.

1.1.5.7 Entrapment

49. For spa pool users there is a potential risk of trapping their hair or body parts in spa pool inlets, outlets and grilles (particularly if they put their head underwater, which should be strongly discouraged). Appropriate control measures, including use of design features, should be used to reduce the risk of entrapment.

1.2 Identification and assessment of the risk

50. The purpose of the microbiological risk assessment is to enable the manager to make a valid decision about the measures necessary to prevent or adequately control the exposure of people near or in the spa pool to infectious agents that could grow in it. The manager will not be able to implement a formal health and safety management system for their spa pool without first conducting a risk assessment. The risk assessment will show that the manager has considered all pertinent factors. The legal requirement for a risk assessment with advice on how to conduct one is

explained in the COSHH ACoP4 and L85.

51. It is the responsibility of the person operating the spa pool (the dutyholder) to

• assess the risks associated with running the spa pool,

• prevent or control exposure to any hazards identified for their employees and other people affected by the running of the spa pool,

• maintain, examine and test any measures used to control exposure,

• monitor exposure in the workplace, if appropriate,

• keep employees and others informed about the hazards and the measures taken to control them,

• train their employees so they can use the control measures correctly, and

• have arrangements in place to deal with accidents, incidents and emergencies.

52. The person who conducts the risk assessment should

• have adequate knowledge, training and expertise to understand the hazard (ie the presence of infectious agents in the spa pool) and risk,

• know how running the spa pool produces the hazard,

• have the ability and authority to collect all the information needed to dothe assessment, and

• have the knowledge, skills and experience to make the right decisions about the risks and the precautions needed.

53. If the dutyholder (spa pool manager) is confident they understand the hazards and risks of running a spa pool, they may choose to do the risk assessment themselves. Alternatively, a responsible employee, safety representative or safety officer within a larger organisation may help with the assessment. If the dutyholder is not confident the expertise to do a risk assessment resides in their organisation they may choose to get help from another competent source, for example a consultant experienced in risk assessment. However, the dutyholder is ultimately responsible for the risk assessment, whoever else was involved in producing it.

1.2.1 Carrying out the risk assessment

54. A number of factors are required to create the risk of acquiring an infectious disease from a spa pool

• the presence of infectious agents (eg Legionella bacteria) in the spa pool;

• suitable conditions for the growth of the infectious agents, eg a temperature of 30¡C to 40¡C, a source of nutrients (organic matter from bathers);

• a way of exposing employees and users to the infectious agents, eg to egionella bacteria in the aerosol created by agitated water; and

• the presence of people who could be exposed to the infectious agents, eg people working on the spa pool, people passing near a spa pool.

55. When conducting the risk assessment the manager must consider the individual nature of their premises and spa pool(s). To help achieve this it is important that an up to date schematic diagram is kept of the spa pool(s) and associated plant. This can be used to decide which parts of the system pose a risk to workers and users.

56. The following general factors need to be considered when carrying out the risk assessment

• The source of the supply water, eg from the mains supply or an alternative.

• Possible sources of contamination of the supply water, eg biofilms within the pipework, bathers, soil, grass, leaves (the latter for spa pools sited outdoors).

• The normal operating characteristics of the spa pool.

• The people who will be working on or near the spa pool or using it.

• The measures chosen to adequately control exposure, including the use of personal protective equipment (PPE).

• Unusual, but reasonably foreseeable, operating conditions, eg breakdowns.

57. In addition, the following specific factors also need to be considered

• The type, design, size, approximate water capacity and designed bather load of the spa pool.

• The type of dosing equipment, including the use of automatic controls, pump arrangements, balance tanks, air blowers etc.

• The piping arrangements and construction materials

• The type of filtration system.

• The heat source and design temperature.

• The chemical dosing equipment, including chemical separation, personal protective equipment, chemical storage arrangements eg bunding.

• The type of treatment to control microbiological activity, eg chlorine.

• The method used to control pH, eg sodium bisulphate.

• The cleaning regime Ð ease of cleaning, what is cleaned, how and when.

• The testing regime, including microbiological tests - the frequency of tests, operating parameters, action required when the results are outside parameters.

58. The significant findings of the risk assessment should be recorded (if the manager has five or more employees). Even if the manager has less than five employees they should consider whether it would be easier to demonstrate to enforcing authorities that a suitable risk assessment has been done if there is a written version.

59. The written risk assessment should be linked to other health and safety records, eg

• the up-to-date plan of the spa pool and plant,

• the description of the correct and safe operation of the spa pool,

• the precautions to take when running/using the spa pool,

• the checks required to ensure the spa pool is working safely, and

• remedial action required in the event the spa pool is not running safely.

60. It is important to link the risk assessment for infectious agents to the assessments for other hazards associated with using a spa pool, eg slips and trips, manual handling, particularly ensuring the control measures implemented for hazards are compatible.

61. Employers are required to consult their employees or their representatives on the identified risks of exposure and the proposed control measures, giving employees the opportunity to comment.

62. It is essential the effectiveness of control measures is monitored. The risk assessment should be reviewed regularly (at least every two years) and whenever there is reason to suspect it is no longer valid, eg

• there are changes to the spa pool or the way it is used,

• there are changes to the premises the spa pool is installed in,

• new information is available about the risks or control measures,

• the results of tests indicate control measures are not effective, and

• an outbreak of a disease (eg Legionnaires' disease) is associated with the spa pool.

1.3 Managing the risk: management responsibilities, training and competence

63. As well as poor design and bad installation, inadequate management, lack of training and poor communication is often associated with the outbreak of diseases such as Legionnaires' disease. Everyone involved in the risk assessment and management of the spa pool must be competent, trained and aware of their responsibilities.

64. The manager of the spa pool should appoint someone to take day-to-day responsibility for controlling the risk identified from infectious agents in the spa pool - they are the responsible person. The responsible person should be a manager, director or someone with similar status and authority. They must be competent and knowledgeable about the spa pool to ensure all operational procedures are carried out effectively. The responsible person must also have a clear understanding of their duties and the overall health and safety management structure and policy of their organisation. If the manager is self-employed they may appoint themselves the responsible person.

1.3.1 Competence

65. The staff who undertake the day-today running of the spa pool, ie are implementing the control measures, need to be suitably informed, instructed and trained, and their suitability assessed. They must be able to carry out their duties in a safe, technically competent manner. Regular refresher training should be given. Records of all initial and refresher training need to be kept. Professional organisations and consultants offer training courses (see Sources of Information for details of relevant professional organisations and trade associations).

66. Training is not the only requirement to ensure the staff looking after the spa pool can do their job. Their competence will be a product of sufficient training, experience, knowledge and other personal qualities. Competence depends on the specific situation of each spa pool and the associated risks.

67. The manager must satisfy themselves of the competency of anyone they bring in to help them run their spa pool.

1.3.2 Implementation of the control scheme

68. The control measures and their implementation should be regularly and frequently monitored. Everyone involved in the running of the spa pool will need proper supervision. Staff responsibilities and lines of communication need to be clearly defined and documented. Communication and management procedures are particularly important if several people are responsible for different aspects of the spa pool's operation. The communication procedures should be regularly checked to ensure they are effective; this also applies to any external people used in the operation of the spa pool.

69. Arrangements should be in place to ensure appropriate staff levels are maintained while the spa pool is being operated. The responsible person or an authorised deputy should be available to discuss the spa pool at all times it is in use.

70. The manager is always responsible for ensuring the control procedures are carried out to the standard required even if they have employed contractors or consultants to help with the running of the spa pool.

1.4 Preventing or controlling the risk from exposure to infectious agents

1.4.1 Using and reviewing control measures

71. It is the spa pool managerÕs duty to ensure the chosen control measures are used properly and not made less effective by other work practices or improper use. This can be achieved by

- making visual checks and observations at appropriate intervals,
- ensuring PPE is being used correctly,
- supervising employees to ensure defined methods of work are being followed,

and

• taking prompt remedial action when required.

72. It is the responsibility of the staff working on the spa pool to ensure the control measures are being used as intended and as they have been instructed. This will include

• using the control measures provided, eg the disinfectant,

• following the defined methods of work, eg standard operating procedures,

• wearing PPE if provided, storing it correctly and removing it in such a way that it cannot cause contamination before eating, drinking, smoking etc,

• practising a high standard of personal hygiene, and

• reporting promptly any defects discovered in the control measures.

73. The condition and performance of the spa pool will need to be monitored to ensure the control measures used remain effective. This should be the responsibility of the responsible person, although it is acceptable for consultants or contractors to provide assistance and advice. This review should include:

• checking the performance of the spa pool and its component parts,

• inspecting the accessible parts for damage and signs of contamination, eg biofilms, and

• monitoring to ensure the treatment regime is controlling the growth of infectious agents. Further details about monitoring are provided in Section 2.3.

1.4.2 Dealing with accidents, incidents and emergencies

74. The Management of Health and Safety at Work Regulations3 and COSHH4 place a duty on employers to establish procedures to deal with situations involving serious and imminent danger. According to COSHH an accident, incident or emergency is any situation where an employee is (or is threatened to be) exposed to a hazardous substance beyond that associated with normal dayto- day activity. During the management of a spa pool this could be exposure to a serious spillage of a chemical used to treat the water or a disease outbreak arising from exposure to infectious agents in the spa pool.

75. The response to an emergency should be proportionate to the risk, so for example a small chemical spillage might not require full evacuation of the whole premises but the detection of certain levels of Legionella bacteria in the spa pool water could require it to be closed down.

76. The spa pool manager must ensure their emergency procedures are capable of

• mitigating the effects of the incident,

• restoring the situation to normal as soon as possible, and

• limiting the extent of any risks to health of the people working on or near and using the spa pool.

77. The emergency procedures (sometimes known as the Emergency Action Plan or EAP) should include details of the following

• the identity of the relevant hazardous substances present, where they are stored and used, and the estimated amount in the workplace on an average day Đ this would be relevant for the water treatment chemicals,

• the foreseeable types of accidents, incidents or emergencies that might occur with the hazardous substances on the premises - chemical and microbiological - eg spills, growth of Legionella bacteria in the spa pool water,

• the special arrangements to deal with the emergency situations not covered by general procedures,

• the safety equipment and PPE required when dealing with an emergency,

• first aid facilities sufficient to deal with an incident until the emergency services arrive, and where the facilities are,

• the role, responsibilities and authority of the people nominated to manage the accident, incident or emergency, eg the person(s) responsible for shutting the spa pool down,

• procedures for employees to follow,

• procedures for clearing up and safely disposing of any hazardous substances or contaminated cleaning equipment,

• regular safety drills, and

• the special needs of any disabled employees or spa pool users, eg assigning employees to help them leave the affected area.

78. As with the overall risk assessment the emergency procedures should be reviewed and updated if circumstances change, eg a new disinfectant is used. A record of procedures must be kept and readily accessible. If appropriate, emergency procedures should be displayed in prominent positions in the workplace for employees or spa pool users to read.

1.5 Record keeping

79. In general the following records must be kept when managing a water system

• the names of the people responsible for conducting the risk assessment, managing and implementing control measures,

• the significant findings of the risk assessment,

• the scheme for controlling the microbiological hazard and details of its implementation (otherwise known as the Normal Operating Plan or NOP), and

• the results of any monitoring, inspection, test or check carried out on the spa pool, along with dates.

80. Together the NOP and EAP are sometimes known as the Pool Safety Operating Procedure or PSOP.

81. Records need to be signed by the person who has produced them, eg recorded monitoring results.

82. The records need to be kept throughout the time they remain current and for at least two years after this. The results of monitoring, inspections, testing or checks should be kept for at least five years.

83. It is recommended the following records are kept specifically for spa pools.

• The name and position of the people who are responsible for managing the spa pool, their respective responsibilities and their lines of communication.

• The names and positions of people responsible for carrying out the various tasks identified to control the microbiological risks.

• The risk assessment(s) and a written scheme of actions and control measures, which will form part of the NOP.

• The plans or schematic drawing(s) of the spa pool and plant.

• Details of precautionary measures that have been carried out, including enough detail to show that they were carried out correctly and the dates done.

• Remedial work required and carried out, and the date of completion.

• A log detailing visits by contractors, consultants etc.

• Cleaning and disinfection procedures and associated reports and certificates.

• The results of the chemical analysis of the spa pool water.

• Information on other hazards, eg chemical, slips and trips.

• Training records of the staff who work on the spa pool.

• Records showing whether the spa pool is out of operation, whether it has been drained down, when it was recommissioned etc.

• The signature of anyone carrying out work on the spa pool or other form of authentication if appropriate.

84. These records can be usefully kept together as the spa pool logbook. This should be a living document and continually amended as its contents change.

85. Further information on records to be kept for spa pools can be found in the HSE guidance on managing health and safety in swimming pools19.

1.6 Responsibilities of designers, manufacturers, importers, suppliers and installers

86. In the commercial setting, the law is enforced under the Health and Safety at Work etc Act 1974 (HSWA)2 but there is also relevant legislation that covers the use of spa pools in a domestic setting17. Responsibilities for enforcement are allocated to HSE for products designed for use at work, and to trading standards departments for consumer products. HSE is also responsible for regulation of the supply of products designed for use at work whether the workplace itself is HSE or Local Authority enforced.

87. Section 6 of the HSWA places a duty on any person who designs, manufactures, imports or supplies a spa pool, to ensure, so far as reasonably practicable, that the spa pool is so designed and constructed that it will be safe and without risks to health at all times. This duty is owed to those who use, set, clean or maintain this equipment.

88. Within this duty there is a requirement to provide persons supplied with the spa pool adequate information about the use for which it is designed and about any conditions necessary to ensure that it will be safe and without risks to health. This applies not only for use of the spa pool but also for its dismantling and disposal.

89. The duty holder must also take steps, so far as reasonably practicable, to ensure that revisions of information are provided, after supply, should any hazard become known that may give rise to a serious risk to health and safety. Where, for example, design faults come to light, the supplier should provide appropriate information to previous clients, as far as is reasonably practicable. There is no time limit specified as to when such a duty to provide information retrospectively should cease; it will depend on what is reasonable in the circumstances.

90. Where certain items are regularly or frequently supplied to the same customer, it is not necessary for information to accompany each delivery, provided the information first supplied remains relevant and up to date. However, it is important to note that the duty to supply information is an ongoing one.

91. Trading standards officers enforce a wide range of legislation but their principal product safety legislation is the Consumer Protection Act 198717. The General Product Safety Regulations 199449 make no substantial changes to the general requirements of the Consumer Protection Act 1987 but they have largely replaced Section 10 of that Act. The Regulations apply to products supplied to consumers for their private use and apply to all persons in the business supply chain who are established in the UK and supply consumer goods in the UK. Suppliers are categorised as 'producers' or 'distributors'.

92. Producers are required to

- place on the market only safe products within the limits of their activities;

• provide relevant information to customers; and

• take measures to keep themselves informed of the risks that products may present and take appropriate action, eg withdraw products from the market if necessary.

93. Distributors are required to act with due care to help ensure that products supplied by them are safe. A 'safe product' under the Regulations presents either no risk or only minimum risk compatible with the product's use.

1.6.1 Designers

94. Designers must carry out such testing and examination as is necessary to ensure they comply with the general duty detailed above but they are also required to eliminate or minimise any residual hazards that may exist by conducting any necessary research and innovation.

1.6.2 Importers

95. Importers are responsible for defects in items, which they supply, even though they may have no control over the manufacturing or design activities that gave rise to those defects. The term 'importer' is not defined in the legislation, but in practice, the person responsible will normally be the person who appears as the importer in the entry for customs purposes.

1.6.3 Suppliers

96. Suppliers must take into account all of the reasonably foreseeable risks from operator error or inattention but not from reckless or wholly inappropriate use. The legislation requires suppliers to take account of any relevant information or advice, which is available to them, which they should have known. Suppliers may also be responsible for defective goods even if they were not aware of the (potential) defects.

1.6.4 Installers and commissioning engineers

97. Installers and commissioning engineers have a duty to ensure, so far as reasonably practicable, that nothing about the way in which the spa pool is erected or installed makes it unsafe or a risk to health at any such time as it is used, set, cleaned or maintained by a person at work. All installations or installation inspections are to be carried out by a competent National Inspection Council for Electrical Installation Contracting (NICEIC), Electrical Contractors Association (ECA) or a similar approved scheme registered electrical contractor who will issue an installation or minor works certificate to the safe installation and the fitting of the correctly rated Residual Current Device (RCD) to BS767136.

98. Designers, manufacturers, importers and suppliers of spa pools under current legislation should ensure that the spa pool is designed, constructed and installed so that it will be safe and without risks to health when used and provide adequate information for the user about the risks of the product.Importantly, this should be

updated in the light of any new information about significant risks to health and safety that becomes available. Suppliers of spa pools and services, including consultancy and water treatment services, should so far as reasonably practicable ensure that measures intended to control the risk of exposure to infectious agents are so designed and implemented that they will be safe and without risks to health.

Part 2

Guidance on the control of infectious agents in spa pools

2.1 Background

2.1.1 Operating spa pools

99. General guidance on controlling Legionella bacteria can be found in the HSE publication LegionnairesÕ disease: The control of Legionella bacteria in water systems. Approved Code of Practice and Guidance (L8)5. Part 2 puts the control measures outlined in L8 in the context of operating a spa pool and also covers the control of other infectious agents.

100. This section provides guidance on the simple principles and practices for maintaining the water in spa pools in acceptable condition. A wide range of individuals and organisations undertakes spa pool maintenance with varying skills including hoteliers, health clubs, local authorities, leisure companies and private owners.

101. To encourage the use of any spa pool it must appear inviting, offer a safe and pleasant environment to use, and be free from irritant substances, infectious agents (viruses, bacteria, protozoa and fungi) and algae.

102. In spa pools the refreshing agitation of the water is achieved by the combination of air jets and pulsating water flow. Splashing of water and bursting of the bubbles breaking through the water surface creates an aerosol immediately above the water surface in the breathing zone of the occupant(s). In LegionnairesÕ disease the principal route of infection is through the inhalation of the bacteria into the lungs with the risk of disease rising with increasing numbers of inhaled bacteria. Rarely, infection may occur by aspiration. Good disinfection and filtration are therefore essential for maintaining health and safety standards in spa pools.

103. The small volume of water, high operating temperature and generally heavy bathing loads makes the water treatment of spa pools more onerous than in conventional swimming pools.

104. Objectives of spa pool water treatment are the same as those for swimming pools, namely

• to remove suspended and colloidal matter and to render the water clear, bright and colourless;

• to remove organic matter, which may act as a source of food for bacteria and give an unaesthetic appearance to the water;

• to provide an appropriate level of disinfectant to control the growth of infectious agents;

• to maintain the pH of the water at an optimum for disinfection; and

• to maintain a comfortable temperature for bathers.

105. There are essentially two types of pollution; that generated by bathers and that from external sources ie atmosphere, surface surrounds and bathing costumes. The pollution generated by bathers comes from

• nose - mucus,

• mouth - saliva,

• skin - perspiration, dead skin, sun tan lotion, cosmetics, shampoo and soap residues

• urine and faecal matter, and

• hair.

2.1.2 Operating natural spa pools

106. The concept of natural spa pools is for the water to remain untreated, but this in itself can pose potential health and safety implications. The water for natural spas should be shown to be of satisfactory microbiological quality before construction of the spa. However, natural spa pools must be managed to control the risk of exposure of users and others to infectious agents. This will usually require the natural spa pool to be managed in the same manner as any other commercial spa pool. Managers of natural spa pools should, therefore, follow the guidance on control measures given here.

2.1.3 Storing water

107. Stored water requires ongoing management if water quality (including aesthetic quality) is not to be impaired. It is especially important to ensure the water in storage does not rise above 20°C. Legionella bacteria and other infectious agents can proliferate in storage at temperature above 20°C, particularly if a biofilm is allowed to develop on the inside of the cistern.

2.1.4 Spa pool water purification

108. Water treatment can be divided into two main steps - filtration and disinfection. Filtration is necessary to maintain a physically clean, clear and safe environment. Chemical or physical disinfection is required to prevent cross infection between bathers and the growth of infectious agents within the water and on the surfaces within the spa pool and itÕs associated water and air circulation system.

109. Effective purification relies on powerful filtration working in conjunction with continuous disinfection via a complete and speedy circulation system, to collect,

clean and disinfect water without plant failure, undue water and chemical wastage or needless expense.

110. To minimise pollution it is essential to encourage good hygienic standards. Bathers should be strongly encouraged to visit the toilets, and to wash and shower before use of the spa pool. Introduction of shampoos, moisturisers and other skin products into spa pools will adversely affect the water balance and therefore bathers should ensure these are removed by showering before entering the pool.

111. The daily spa pool maintenance programme needs to achieve proper physical operation of the spa pool and provide a suitable chemical balance and the correct microbiological control. To ensure optimum water quality within the spa pool it is essential that the turnover time of the spa pool and the design bathing loads do not exceed recommended limits (see below).

2.1.5 Information managers should provide for users

112. The risk assessment will identify the information that should be provided to customers, and may include having a wall clock clearly visible from the spa pool and a notice pointing out the recommended bathing time along with the maximum number of people allowed in the spa pool at any one time. They may also require a notice, clearly displayed near the spa pool, advising individuals of the correct procedures when using the spa pool. For example

• It is recommended that bathers do not wear sun tan lotions or skin creams in the spa pool.

• Bathers should use the toilet and shower before entering the spa pool.

• Bathers should not use the spa pool if they have had diarrhoea within the last 14 days.

• Bathers should be discouraged from swallowing the spa pool water.

• It is recommended that bathers do not exceed 15 minutes immersion at a time.

• Bathers should not exceed the maximum number permitted in the spa pool .

• Children under four should not use the spa pool.

• Children (and others) who are unable to keep their faces out of the water should not use the spa pool.

• All other children using the spa pool must be supervised.

• Babies' nappies should not be changed beside the spa pool.

• It is recommended the spa pool is not used after a heavy meal or while under the influence of alcohol or sedatives.

• If intended users are suffering from diseases of the heart and circulation, skin conditions, are immunosuppressed, subject to fits, or taking drugs affecting the cardiovascular or nervous systems, they should seek medical advice before bathing in spa pools.

• Pregnant women are advised to consult with their doctor before using a spa pool (see section 1.1.5.2) (This is not an exhaustive list and the information that needs to be displayed will depend on the risks identified for each spa pool.)

2.2 Treatment programmes

2.2 Treatment programmes

2.2.1 Maintaining water quality

2.2.1.1 The effect of pH on disinfectants

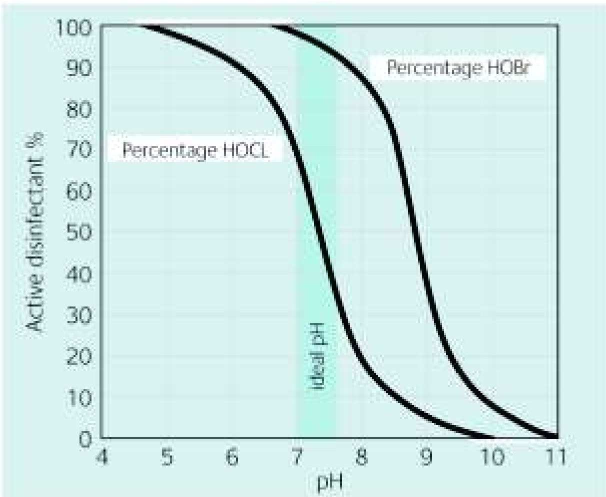
113. The pH (a logarithmic scale) is a measure of the degree of acidity or alkalinity (also known as the basicity) of the water:

0 ⟵ ACID —— 7.0 —— ALKALI ⟶ 14.0
neutral

Ideal range 7.0 - 7.6

The most important factor in water balance is pH and the ideal ideal pH range is similar to the pH of most body fluids.

Figure 2: **The effect of pH on disinfection**



114. Figure 2 shows the effect of pH on the disinfection efficiency of chlorine and bromine. It should be noted that, depending on the nature of incoming mains water and the disinfectant used, the spa pool water may need to be adjusted to the ideal pH range by the use of chemical treatment. Acidic pH adjusters include sodium bisulphate and hydrochloric acid, and alkaline pH control is achieved with sodium carbonate (soda ash).

2.2.1.2 The effect of disinfectantson pH

115. 1,3-bromochloro-5,5- dimethylhydantoin and sodium dichloroisocyanurate tend to be relatively neutral when dissolved in spa pool water and have little effect on the pH. The nature of the incoming mains water supply tends to determine the pH adjustment required.

116. Trichloroisocyanuric acid forms an acidic solution (pH3) in water and will tend to lower the pH value. An alkaline pH adjuster may be necessary to maintain the

optimum pH but the degree of pH adjustment will be dependent on the nature of the incoming mains water supply.

117. Sodium and calcium hypochlorite will both raise the pH of the spa pool water, so an acid pH adjuster may be required. Again the degree of pH adjustment needed will depend on the nature of the incoming water supply.

2.2.1.3 Water balance

118. The pH, Total Alkalinity, Total Dissolved Solids, Temperature and Calcium Hardness of water are related in a complex way and are the main factors in determining the balance of the water. Balanced water is neither scale forming nor corrosive and may be measured using a number of indices such as the Langelier, Palintest or saturation. In commercial spa pools the frequency of water replacement and draining of the spa pool is likely to limit the requirement for water balancing.

2.2.1.4 Clarity

119. Cloudiness in the water is often evident if the spa pool has been left unused and may be attributable to a number of different factors. These include failure of the circulating pump, incorrect hand dosing of the spa pool with water treatment chemicals leading to a lack of disinfectant, the presence of undissolved chemicals, algal growth, incorrect backwashing procedures and bacterial overgrowth. Further advice should be sought from a suitable consultant if problems persist.

2.2.1.5 Total Dissolved Solids (TDS)

120. The measure of the concentration of dissolved materials present in the water, the majority of which have been introduced from the water treatment chemicals and from the bathers using the spa pool, is termed the total dissolved solids. This concentration reflects the management of spa pool usage and control of water replacement. A maximum of 1000 mg/l over the fill water of TDS is recommended in spa pools, above which corrosion of the spa pool water distribution system may become more apparent. Planned water replacement will normally prevent such occurrences.

2.2.1.6 Biofilms

121. The spa pool, pipework and balance tank should be constructed of materials known not to support the growth of infectious agents and which comply with BS 692050. It should also be possible to inspect and clean not only the surfaces of the tanks and spa pool but also the inside of the pipework and, for this purpose, appropriate access points should be included in the design or the pipes should be readily removable.

2.2.1.7 Algae

122. There are 3 common types - green, blue-green, and brown or red.

2.2.1.8 Green algae

123. Green algae are free floating; turning the spa pool water cloudy green. They are easily killed by treatment e.g. chlorine.

2.2.1.9 Cyanobacteria

124. Cyanobacteria used to be known as blue-green algae, although they are generally black in appearance. They are found on floors and walls in small dots or blotches, are resistant to algicides and often cause surface staining.

2.2.1.10 Brown or red algae

125. Brown or red algae are usually yellow or yellow brown and are sometimes found on spa pool walls, floors and steps. They may also be rust red, green or pink in colour.

2.2.2 Spa pool area hygiene

See section 2.4 1

2.2.3 Chemical storage

126. Care must be taken to ensure that chemicals are stored under the correct conditions. Acids and alkalis should be stored separately in secure, well-ventilated, dry storage areas (bunded if necessary, ie to contain spills of liquid chemicals). Each area should be marked externally with the appropriate warning sign. It is inadvisable to store spa pool chemicals with petrol or oil, e.g. a domestic spa owner should not store pool chemicals in a shed that also houses a petrol mower. Accidental mixture of these chemicals could result in an explosion or facilitate spontaneous combustion.

2.3 Monitoring

127. It is the responsibility of the owner to arrange routine microbiological or chemical testing. However, HSE and Local Authority inspectors do have the power to take water samples under the HSWA as may be required during inspections/investigations.

2.3.1 General monitoring

128. Poolside testing and recording of residual disinfectant and pH levels should be undertaken before the spa pool is used each day and thereafter at least every 2 hours in commercial spa pools. The chemical tests required are On-site tests

• Colour

• Clarity

• Temperature

• Number of bathers

• Chlorine (free, total and combined) or bromine in pool

¥ pH

129. Laboratory analysis is not part of the daily regimen but may be required, for

example, monthly. The frequency of laboratory analysis should be indicated from your local risk assessment. Chemical tests include

- Permanganate value (4 hours @ 27¡C)
- Total dissolved solids*
- Bromide/chloride depending on disinfectant*
- Ammoniacal nitrogen
- Albuminoid nitrogen
- Nitrite nitrogen
- Total Alkalinity*
- Bicarbonate alkalinity
- Hydroxide alkalinity
- Total hardness*
- Calcium hardness
- Magnesium hardness
- Sulphate*
- Iron*
- Copper*
- Zinc*

* These tests can be done at the side of the spa pool, but for reliable results to show how the spa pool is being managed laboratory analysis should be used.

130. Details of standard testing procedures are provided in Appendix 3. A logbook should be available for recording the results, it should state the acceptable limits for parameters tested, together with any remedial action to be taken in the event of a test result being out of specification. Records should be kept for a minimum of 5 years as required by the Approved Code of Practice L85.

131. The total dissolved solids (TDS) should be monitored daily, and the water balance weekly if required. In areas where the water is naturally low for calcium hardness and alkalinity, basic water balance chemicals may be required to stop the water being aggressive in the spa pool. However, in commercial spa pools, water replacement frequency should be such that it obviates the need for water balance (depending on the source water). Similarly TDS monitoring may not be required if the water is replaced frequently.

132. Routine microbiological analysis should also be undertaken to ensure that optimum water treatment conditions are being maintained. While chemical analysis is of benefit to monitor the efficiency of the water treatment system in dealing with the pollution loading, it is important that it is carried out together with microbiological analysis to enable a complete assessment of the water treatment

operation and management.

133. Information obtained from regular monitoring can indicate

• whether or not water replacement and backwashing are being undertaken at sufficient frequency,

• disinfectant levels are adequate,

• show whether or not the operation of the water treatment plant is coping effectively with the bather load,

• highlight any unnecessary hand dosing of water treatment chemicals,

• provide information on the condition of the filter bed, and

• provide advanced warning of failure of filter, pumps, valves etc.

2.3.2 Sampling for chemical analysis

134. A one-litre sample of spa pool water is required for a comprehensive chemical analysis in the laboratory. This should be taken in a clean one-litre polythene container, which, prior to filling, has been thoroughly rinsed with water from the spa pool to be sampled. The sample should be delivered to the laboratory on the same day as sampling. However, if this is not possible it must be refrigerated (4-8¡C) until it can be delivered to the laboratory the next day.

135. The place and point of sampling, the time, the pH and the concentration of free and combined disinfectant should be noted at the time of sampling and provided to the laboratory together with the sample. Ideally the sample should be taken about 200 to 400mm below the water surface.

2.3.3 Monitoring for infectious agents

136. The spa pool manager has the responsibility for ensuring that microbiological samples are taken at appropriate intervals and the results recorded in the spa pool log book together with any remedial actions and follow up samples following an adverse report. In general, a microbiological sample should be taken based on a risk assessment, which would take into account any factors that may have an effect on water quality.

137. Regular microbiological testing will provide an assurance that operating conditions are satisfactory if

• it is performed by trained and competent personnel to prevent sample contamination;

• microbiological analysis is carried out in a laboratory accredited for the analysis to ISO1702551;

• chemical tests are performed, preferably on site, at the time of sample collection, eg pH value and the concentration of free and total disinfectant in the spa pool water, a review of the maintenance records and bather numbers for the spa pool, information on any mechanical failures, the water appearance, and other untoward events is carried out and noted on the sample submission form.

138. Microbiological samples for indicator organisms should be taken at least once a month as a routine and quarterly for Legionella. More frequent sampling may be required depending on the risk assessment, eg if the spa pool is being intensively used and certainly if there are any adverse health effects reported by the bathers. Spa pools that are situated outdoors have additional demands placed on the disinfection and filtration systems from environmental contamination by dust, debris etc, so it is important that such factors are taken into account when determining a monitoring schedule. If adverse health effects are suspected the enforcing authority (HSE or the Local Authority) and the microbiologist in the testing laboratory should be informed; as required they will then notify the CCDC within the Local Health Protection Unit. Microbiological sampling should also be done

- when a spa pool is first used or recommissioned,
- after a report of ill-health following spa pool use,
- if there are problems or contamination incidents, or
- alterations in the treatment/maintenance regimes.

2.3.4 Microbiological tests

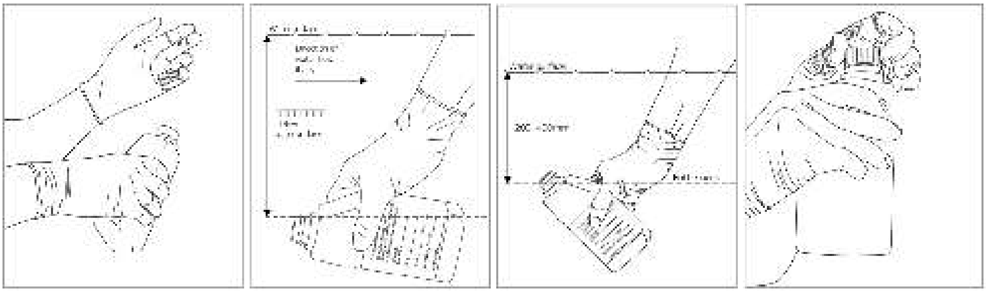
139. Tests for indicator organisms should include an aerobic colony count (sometimes called the total viable (colony) count or plate count)), coliforms, Escherichia coli, and Pseudomonas aeruginosa. In addition, tests should be quarterly for Legionella. The aerobic colony count (ACC) after 24 hours incubation at 37¡C will give an indication of the overall microbiological quality of the spa pool while the continued presence of coliforms and especially E. coli will indicate the presence of serious contamination arising as a result of a breakdown in the treatment system. The presence of the potential pathogen P. aeruginosa is also an indication of treatment failure with likely colonisation and biofilm formation on the spa pool filter and within other parts of the system. It is a more sensitive indicator of sustained management problems than the coliforms and may be found in their absence but is usually associated with an elevated ACC.

140. If there are health problems associated with the use of the spa pool, it may be necessary to test for other organisms, based on epidemiological evidence, such as Staphylococcus aureus, Cryptosporidium, Giardia and perhaps viruses. In these circumstances advice should first be sought from the local Health Protection Unit and the microbiologist.

2.3.4.1 Sampling procedure

141. Sampling bottles must be made for this purpose and must be sterile, shatterproof and contain a neutralising agent for the disinfectant in use. Glass bottles must not be used. For spa pools using chlorine or bromine-based systems, sodium thiosulphate is a satisfactory neutralising agent and 180mg/l is usually sufficient to

Figure 3: **Illustration of how to collect a sample for microbiology**

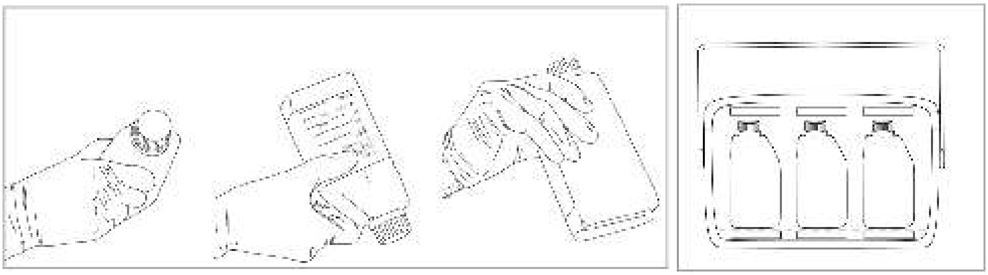


1. Aseptically removing the bottle top

2. Immerse bottle 200-400mm below the surface, keeping bottle almost horizontal but tipped slightly to ensure neutraliser is not tipped out

3. Tilt bottle up to approximately 45° to fill

4. Remove bottle. If the bottle is full to the brim pour off a small amount to leave 1-2cm air above the water surface. Replace the cap



5. Invert a few times to mix the contents and place the bottle in a cool box for transport

6. Transport to laboratory as soon as possible in an insulated container - process on day of collection

neutralise up to 50ppm of chlorine. A mixture of lecithin and Tween 20 can be used to neutralise PHMB, specific details and further advice should be sought from the testing laboratory. If other disinfection systems are in use, the testing laboratory must be informed before the sample is taken to ensure that the appropriate neutraliser is supplied, if an appropriate neutraliser is not available then the sample must be tested as soon as possible, the testing laboratory will need to take into account the time delay before testing is carried out when interpreting results. Samples taken for chemical examination require a separate bottle without a neutralising agent.

142. Sample bottles for microbiological testing should be either individually wrapped or disinfected by wiping with, for example, an alcohol swab before use. For routine monitoring for indicator organisms a sample bottle of 500ml should be used and for Legionella sample bottle of at least 1000ml. Unlike bottles for chemical testing samples, these should not be rinsed with the water to be tested. To take the sample, the stopper or cap is first removed with one gloved hand making sure that

nothing touches the inside of the bottle or cap. The collection of a sample is illustrated in figure 3. While the bottle is being plunged into the water the long axis should be kept approximately horizontal but with the neck pointing slightly upwards to avoid loss of the neutralising agent. The bottle is quickly immersed to about 200-400mm below the pool surface, at which point the bottle is tilted upwards to allow it to fill. On removal from the water, the cap is immediately replaced, the sample shaken to disperse the neutraliser, and then sent to the laboratory without delay to enable analysis preferably on the same day and certainly within 24 hours of sampling. In transit the sample should be protected from light and placed in an insulated container maintained at approximately 2 - 8¡C by freezer or ice packs. The sample container should not come in direct contact with the freezer packs.A record should be made of the pH value and the active disinfectant residual determined at the time of sampling. This and any other relevant information should accompany the sample to the testing laboratory to enable appropriate interpretation of the results

143. Routine sampling should be done when the spa pool is in use, preferably when heavily loaded or immediately thereafter.

2.3.5 Recommended microbiological standards for spa pools

144. If these indicator microbiological results are unsatisfactory a review of the records should be undertaken and the microbiological tests repeated immediately. Sampling from the balance tank may also be considered at this point. If the results show gross contamination (see Section 2.3.3) then the spa pool should be taken out of use immediately and any remedial actions implemented before resampling.

145. If results are still unsatisfactory after the repeat samples and investigation, immediate remedial action is required that may necessitate the spa pool being closed. Note: the investigation may require the help of the laboratory that does the tests, the local council Environmental Health Department, or an independent consultant.

2.3.5.1 Aerobic colony count

146. The colony count should be carried out in accordance with BS EN ISO 622252 (BS 6068-4.5) but with incubation at 37°C for 24 h. These test conditions are set to isolate the range of organisms that can colonize and cause infections in bathers. The ACC can become increased where there is a higher bather load, reduced chlorine residual or where there are defects in water treatment. The aerobic colony count should normally be 10 or less colony forming units (cfu) per millilitre of spa pool water. If a colony count above 10cfu/ml is the only unsatisfactory microbiological result, and residual disinfectant and pH values are within recommended ranges, the water should be retested.

2.3.5.2 Total coliforms

147. The presence of coliforms indicates

that the treatment has failed to remove this contamination. Coliforms are sensitive to disinfectant and should be absent in 100ml of spa pool water. A repeat sample should be taken whenever coliforms have been detected. A coliform count of up to 10cfu/100ml is acceptable provided that

• the aerobic colony count is less than 10cfu/ml;

• there are no E. coli present; and

• the residual disinfectant and pH values are within recommended ranges.

2.3.5.3 Escherichia coli

148. Escherichia coli is normally present in the faeces of most humans, mammals and birds. It is widely used as a specific indicator of faecal contamination as it is unable to grow within the environment. The presence of E. coli in spa pool water is an indication that faecal material has entered the water from contaminated skin, or from faecal material that has been accidentally or deliberately introduced. It also indicates that the treatment has failed to remove this contamination. E. coli should be absent in a 100ml sample. However, because most bathers will have some faecal contamination of their skin, particularly if they have not showered before bathing, a single positiv sample may be the result of recent superficial contamination by a bather that has not yet been decontaminated by the disinfectant residual. A repeat sample should then be taken.

2.3.5.4 Pseudomonas aeruginosa

149. Well-operated spa pools should not normally contain P. aeruginosa. If the count is over 10 P. aeruginosa per 100ml, repeat testing should be undertaken. Where repeated samples contain P. aeruginosa the filtration and disinfection processes should be examined to determine whether there are areas within the spa pool circulation where the organism is able to multiply.

There is a risk of an outbreak of folliculitis when the count exceeds 50cfu/100ml so the spa pool should be closed, remedial action taken and the water resampled (see Section 2.3.3).

Number/litre	Interpretation
$<10^2$	• Under control
$\geq 10^2$ to $\leq 10^3$	• Resample and keep under review. • Advised to drain, clean and disinfect. • Review control & risk assessment; carry out remedial actions identified. • Refill and retest next day and 2-4 weeks later.
$>10^3$	• Immediate closure. Exclude public from pool area • Shut down spa pool. • Shock the spa pool with 50mg/l free chlorine circulating for 1 hour or equivalent. • Drain, clean and disinfect. • Review control & risk assessment; carry out remedial actions identified. • Refill and retest next day and 2-4 weeks later. • It may be advisable to alert the local Health Protection Unit. • Keep closed until legionellae are not detected and the risk assessment is satisfactory

2.3.5.5 Legionella pneumophila

150. Well-operated spa pools should not normally contain Legionella species. The microbiological results should not be considered in isolation but in the context of the management records for the spa pool.

151. The table above illustrates the guidelines for interpretation of Legionella.

2.3.6 Closing a spa pool

152. The spa pool should be closed following a routine microbiological test if

• the result suggests gross contamination (see above and below); or

• there is other chemical or physical evidence that the spa pool disinfection system is not operating correctly (eg if the records show that residual disinfectant values were inadequate or erratic and frequently too low, or the spa pool water is of unsatisfactory appearance). Where there is evidence of gross contamination the spa pool should be closed to prevent illness in users and those working near the spa pool. The appropriate enforcing authority should be contacted and competent help and advice sought.

153. The following should be considered gross contamination

• greater than 10 E.coli per 100ml in

combination with - an unsatisfactory aerobic colony count (>10 per 100ml) and/or - an unsatisfactory P.aeruginosa count (>10 per 100ml)

• greater than 50 P.aeruginosa per 100ml in combination with a high aerobic colony count (>100 per ml)

• greater than 1000 cfu per litre Legionella species

2.3.7 Additional testing in outbreaks

154. In the event of an outbreak of illness associated with a spa pool additional microbiological testing will be undertaken by the appropriate enforcement agency, eg the Local Authority, following discussion with the CCDC and chairman of the outbreak control team. If disinfection is adequate then bacterial and viral tests are unlikely to represent the conditions at the time of the infectious event. Cryptosporidium or Giardia contamination may still be detectable through examination of backwash water and filter material (although routine testing for Cryptosporidium and Giardia is not considered useful).

2.3.8 Summary of Checks

155. Daily Before opening the spa pool

• Check water clarity before first use.

• Check automatic dosing systems are operating (including ozone or UV lamp if fitted).

• Check that the amounts of dosing chemicals in the reservoirs are adequate.

Table 2. **Routine Microbiological Sampling**

Microbiological result	Action
Colony count at 37°C > 10cfu/ml	If a colony count above 10cfu/ml is the only unsatisfactory microbiological result, and residual disinfectant and pH values are within recommended ranges, the water should be retested.
Colony count at 37°C >100cfu/ml	Check treatment system and manual testing results records immediately and implement any remedial action as required
Coliforms and *E. coli* present (>1cfu/100ml)	Occasional positive samples may occur if the spa pool has been sampled immediately after a contamination event before the disinfection system had time to be effective. A repeat sample should be taken whenever coliforms have been detected.
Coliforms >10cfu/100ml	A coliform count of up to 10cfu/100ml is acceptable provided that the residual disinfectant and pH values are within recommended ranges, there are no *E. coli* present and the aerobic colony count is <10/ml.
Coliforms present on repeat test	If coliforms are found on a repeat test it indicates that the disinfectant regime is ineffective. The spa pool systems and risk assessment should be reviewed and the spa pool taken out of action, drained, cleaned and disinfected before resampling.
P. aeruginosa present (>50cfu/100ml) with or without raised coliform, *E. coli* or colony count	Take spa pool out of operation and treat as above
Cryptosporidium or Giardia	Take spa pool out of operation immediately and seek advice of a public health microbiologist over the appropriate disinfection procedures

• Determine pH value and residual disinfectant concentration. Throughout the day

• Continue to check automatic dosing systems are operating (including ozone or UV lamp if fitted).

• Determine pH value and residual disinfectant concentration every 2 hours.

• Determine the TDS, where appropriate. At the end of the day after closing the spa pool

• Clean water-line, overflow channels and grills.

• Clean spa pool surround.

• Backwash sand filter (ensure water is completely changed at least every 2 days) - for diatomaceous earth filters comply with the manufacturer's instructions.

• Inspect strainers, clean and remove all debris if needed.

• Record the throughput of bathers, unless water is being changed- continuously.

• Record any untoward incidents.

156. To be done at every drain and refill

• Drain and clean whole system including balance tank.

• Clean strainers.

• Check water balance after the refill, if necessary.

157. Monthly

• Microbiological tests for indicator organisms.

• Full chemical test (optional).

• Clean input air filter when fitted.

• Inspect accessible pipework and jets for presence of biofilm; clean as necessary.

• Check residual current circuit breaker /earth leakage trip is operating correctly.

• Check all automatic systems are operating correctly eg safety cut-outs, automatic timers etc.

• Disinfectant/pH controller - clean electrode and check calibration (see manufacturerÕs instructions).

158. Quarterly

• Thoroughly check sand filter or diatomaceous earth filter membranes.

• Where possible clean and disinfect airlines.

• Legionella tested by laboratory.

159. Annually

• Check all written procedures are correct

• Check sand filter efficiency.

2.4 Cleaning and disinfection

2.4.1 Cleaning

160. Dirt from around the spa pool must not be allowed to enter it. It is essential to maintain the spa pool, the balance tank, associated components, and the surrounding walkways in a good hygienic condition by the implementation of regular cleaning procedures.

161. The spa pool water line, overflow channels, strainers and grills, and the surrounding area should be cleaned regularly, ideally on a daily basis using a solution of free chlorine, with a concentration of 5-10mg/l. If the water line, or overflow channels require an abrasive cleaner, a small amount of sodium carbonate or bicarbonate can be placed on a damp cloth and applied sparingly. The areas around the spa pool (ie outside it) are often difficult to clean and a hose may need to be employed in conjunction with brushing of the floor surfaces.

162. The materials described in paragraph 161 are compatible with spa pool water treatment. Some other cleaning materials may have a chlorine/bromine demand (ie neutralise these disinfectants) and any carry-over into the spa pool water may react with the residual disinfectant and/or be incompatible with the fabric of the spa pool and surrounding area. Some cleaning agents may interfere with the sensors/probes of automatic controllers. Thus if other special cleaning materials are being considered for use they must first be shown to be compatible with the pool water treatment and spa materials.

163. It should be noted that flexible hoses can become colonised with bacteria including Pseudomonas aeruginosa and Legionella and therefore will need regular disinfection by filling and soaking with a solution containing 10 -50mg/L of free chlorine for 1-5 hours and wiping the outside with a chlorine solution.

164. The whole system should be drained and cleaned at least once per week. At this time the inside surfaces of the balance tank should be cleaned in the same manner as those of the pool (paragraph 161 above) paying particular attention to the water line and not forgetting to clean and disinfect the underside of the lid as this can become a focus for microbial growth.

165. The areas behind the headrests can also harbour growth so these should be removed each time the pool is drained down and the headrest and the area behind it carefully cleaned.

166. If covers are used on the spa pool these should be cleaned inside and out once a week using a solution of 10 mg/L of free chlorine. Covers should be stored dry in a clean area while not in use.

167. Once a month, when the pool is drained down the jets should be removed. The jets and pipework behind them, and elsewhere where the pipework is accessible, can then be inspected for the development of biofilm and cleaned as necessary.

2.4.2 Routine disinfection

168. A variety of disinfectants (eg chlorine and bromine releasing chemicals, PHMB) are used in spa pools. The spa pools may either be treated individually or as part of a combined swimming pool water treatment system of the type found in leisure complexes. The nature of the incoming mains water supply needs to be taken into consideration before a selection of the disinfectant can be made.

169. Various features, eg the elevated temperatures, amount of sunlight present, high turbulence caused by the hydrotherapy jets and/or aeration, and high organic loading due to heavy use patterns, may influence the maintenance of disinfectant levels. Where chlorinating disinfectants are used a free chlorine residual of 3-5 mg/l should be maintained in the spa pool water and for bromine 4-6 mg/l of total active bromine. The efficacy of the disinfectant is directly related to the pH of the water.(see figure 2). These values are only correct for water at pH 7. In commercial spa pools the

introduction of water treatment chemicals must be automatically controlled. Hand dosing should NOT be used except in emergencies such as plant failure or for shock treatment.

170. The process of disinfection using a chlorinating agent results in the formation of free and bound (combined) chlorine. Combined chlorine has slow and little disinfectant effect. It is formed by the reaction of free chlorine with organic materials arising from bather pollution eg urine and perspiration. The efficiency of the disinfection system to cope with the bather load is reflected by the concentration of combined chlorine. The ideal combined chlorine concentration is 0mg/l, however, a concentration of less than 1mg/l is normally considered acceptable. Above this level irritation to the mucous membranes of the eyes and throat may occur.

171. Disinfection using a brominated chemical results in combined bromine being formed as the predominant and effective disinfectant. Free and combined bromines are not usually differentiated between when monitoring the spa pool water disinfectant concentration, since combined bromine is still an effective disinfectant.

172. For spa pools that form an integral part of a leisure pool system, where chlorinating disinfectants are used in conjunction with ozone the residual disinfectant concentration required in the spa pool water will be dependent on spa pool design and attaining satisfactory microbiological results. The microbiological results should indicate low colony counts and the absence of Pseudomonas aeruginosa and Legionella bacteria.

173. Problems have been encountered with microbiological contamination of the deozonising filter media, eg carbon. Low residual disinfection concentration can encourage microbiological growth, both in the spa pool water and subsequently in the filter media. Care must therefore be taken to ensure that a satisfactory residual disinfectant concentration is attained which will not permit microbial growth. In addition it may be necessary to backwash activated carbon or hydroanthracite filters with water chlorinated to 10mg/l by additionof chlorine to the strainer basket or better still through the balance tank.

174. No disinfectant will work effectively if there is accumulation of organic matter in the strainers, filters and pipework etc.

2.4.2.1 Removal of algae

175. If algal growth on the pool surfaces becomes a problem, raising the concentration of disinfectant in the pool to around 10mg/l will effectively kill green algae, whereas blue-green and red algae usually require scrubbing in conjunction with this elevated concentration of disinfectant. If problems persist an expert should be consulted.

2.4.3 Disinfectants

176. Note: for all chlorine-based products the active disinfectant is hypochlorous

acid.

2.4.3.1 Sodium hypochlorite

177. Sodium hypochlorite is usually supplied as a solution having a concentration of 12-15% available chlorine. It should be stored under cool conditions and used within its expiry date (a maximum of three months). Using sodium hypochlorite will raise the pH of the spa pool water.

2.4.3.2 Calcium hypochlorite

178. Calcium hypochlorite is supplied in powder, granular or tablet form, and must be dissolved in a suitable reservoir/feeder before being injected into the spa pool water. In hard water areas more frequent backwashing of the filters may sometimes be required to minimise the occurrence of blockages in the filtration and distribution pipework due to the deposition of calcium salts. Using calcium hypochlorite will also raise the pH of the spa pool water.

2.4.3.3 Chloroisocyanurates

179. These are commonly used in domestic spa pools and are available as slowly dissolving tablets (trichloroisocyanuric acid) or rapidly soluble granules (sodium dichloroisocyanurate). Trichloroisocyanuric acid should be delivered via a dosing unit. However, care must be taken to ensure that the controller is compatible with cyanuric acid at concentrations in excess of 20mg/l. Sodium dichloroisocyanurate is only suitable for dosing directly into the spa pool water and normally should only be applied in this way as an emergency measure. Using dichloroisocyanurates will usually have little or no effect on the pH of the spa pool water, although this can depend on the source of the water. Using trichloroisocyanuric acid will tend to lower the pH.

180. The use of chloroisocyanurates results in the addition of cyanuric acid to the spa pool water and its concentration should be maintained below 200mg/l by dilution with fresh water. Cyanuric acid concentrations above 200mg/l can encourage algal growth and may prevent the release of free chlorine into the spa pool water (see above).

2.4.3.4 Solid bromine based disinfectants Bromochlorodimethylhydantoin

181. The first solid tablet Ôbromine' donor was 1,bromo-3-chloro-5,5-dimethyl hydantoin, known as BCDMH. This is a slow dissolving tablet, designed to be used in a 'soaker' feeder, where a portion of the circulating water is by-passed through the Brominator (feeder). BCDMH can also be used in a pre-filled 'granular' feeder device, which may float (with or without additional minerals) or be plumbed in to the circulation system. It must be added from a suitable dosing unit and ideally injected prior to the filter.

182. This is probably one of the most frequently used disinfectants in spa pools in the UK, although generally it is more expensive than the chlorine based alternatives.

The use of BCDMH has been associated with a rapid onset skin rash, but only when the water was not being replaced as recommended. Other solid bromine disinfectants

183. Other brominated hydantoins have been introduced more recently. The most popular is a mixture of 60% BCDMH, 27.4% 1,3-dichloro-5, 5-dimethyl hydantoin (DCDMH), 10.6% 1,3-dichloro-5-ethyl-methyl hydantoin (DCEMH) and 1.0% sodium chloride. The additional chlorine in this mixture means it is more acidic and dissolves faster than pure BCDMH.

2.4.3.5 Non-halogen disinfectants

184. A disinfection system based on PHMB (poly hexamethylene biguanide hydrochloride) has been used as a three-part system, where the second part is hydrogen peroxide and the third an effective algicide, for many years in swimming pools.

185. A version for spa pools, still based on PHMB and a three-part system but with different additional parts, has now been introduced. All three parts must be used as instructed to ensure safe, clean water. PHMB has no effect on pH and the residual disenfectant is maintained at 50mg/L.

2.4.3.6 Ozone with residual disinfection

186. Ozone may be used in conjunction with residual disinfection. The type of ozonisation used depends on the spa pool installation. Where spa pools are installed as an integral part of a leisure pool water treatment system, water treatment is sometimes combined with that of the main leisure pool and ozone treatment would normally be followed by deozonisation prior to residual disinfection. Free chlorine residuals will still need to be maintained between 3-5mg/l, bromine at 4-6mg/l, PHMB at 50mg/l and isocyanurates at 3-5mg/l to ensure adequate disinfection.

187. Alternatively, trickle stream ozonisation is used sometimes where the ozone is not removed by a deozonisation bed prior to the addition of the residual disinfectant. The ozone should be at such a concentration to ensure that 0.01ppm ozone is not exceeded in the atmosphere above the spa pool water. The residual disinfectant may be any of those mentioned earlier. The ozone generator should be checked daily to ensure it is operating correctly. The system must be maintained and cleaned as specified in the manufacturer's instructions.

2.4.3.7 Ultraviolet light

188. Ultraviolet light has been shown to have a killing effect on bacteria. However, as with ozone, it only renders the water bactericidal at the point of use and therefore additional (residual) disinfection by an oxidising disinfectant (eg residual chlorine or bromine) is required to prevent cross contamination in the spa pool water and to deal with the effective breakdown of bather pollution. The system must be maintained and cleaned as specified in the manufacturer's instructions.

2.4.3.8 Other disinfectants

189. There are a variety of other types of disinfectant available on the market. It is important that the manager is satisfied that the disinfectant used has been independently proved to be capable of providing satisfactory chemical and microbiological water quality and satisfies the Biocidal Products Regulations11,12.

2.5 Design and construction

2.5.1 Specific design issues

2.5.1.1 Pipework

190. Legionella have been shown to colonise water fittings and pipework, and this is facilitated by poor water-flow or by the presence of dead-legs i.e. areas where water is stagnant or is becoming stagnant. In a recent investigation of an outbreak of Legionnaires' disease associated with the use of a hotel spa pool, it was found that a piece of redundant pipework still connected to the spa pool had probably acted as a continuing source of infection. Pipe made of plastic may readily support microbial growth; the ability to support growth depends on the composition of the particular material 53,54,55. The use of flexible corrugated plastic pipe also increases the surface area for growth and can create areas that are difficult to clean in the valleys between the ridges of the corrugations. Corrugated pipe should therefore be avoided as much as possible. All non-metallic materials used in the construction of the spa pool that come into contact with water continuously or intermittently should be suitable for use in contact with potable water and comply with BS692050, which includes a test to show that the material does not support microbial growth. Materials satisfying these requirements are listed in the Water Regulations Advisory Scheme's Water Fittings and Materials Directory (this document is updated twice a year, so refer to WRAS website [www.wras.co.uk] for latest version).

191. Pipework should be designed to minimise the length of pipe runs, the surface area for growth and the number of pipe fittings. Provision should also be made in the design to facilitate ease of access to all pipework for maintenance, draining, cleaning and disinfection. Ideally it should be possible to remove pipes to enable them to be cleaned internally or replaced should they become heavily colonised.

2.5.1.2 Design

192. Overall spa pool design must conform to the appropriate Regulations, eg the Electricity at Work Regulations 198937, Water Supply (Water Fittings) Regulations 199913, for maintaining safety and the chemical and microbiological quality of the water.

193. Water treatment systems are an integral part of the architectural, structural and mechanical design and must be addressed from the very start of the project. For example, water treatment plant design must take into account

- bathing load,
- circulation rate,
- turnover period,
- choice of treatment/disinfection system,
- circulation hydraulics,
- balance tank,
- plant room,
- filtration (eg sand, diatomaceous earth, commercial cartridges, ground glass [AFM]),
- chemical treatment and storage areas,
- operation,
- mains water quality, drainage and dilution, and
- access for operation and maintenance.

194. It is important to ascertain the anticipated maximum bathing load from the client prior to making calculations for pipework, pump and filter sizing. The circulation/filtration pump must be sized along with the filter to achieve the turnover period specified and the filter must be capable of maintaining the spa pool water in a clean and pleasant condition when the spa pool is being used at the full limit of the design bathing load.

195. Spa pool design has become a dynamic business with the constant introduction of new ideas. As a consequence spa pools come in many shapes and sizes with many different configurations of shells, jets, pumps, filters, valves, heaters and controls. All too often these design changes are made without consideration of their effect on the risk of microbial growth.

196. Despite this, the nature of the hazard remains unchanged. Of particular importance is the length of pipework associated with each individual spa pool and the associated large surface area of pipework available for potential colonisation by bacteria with the resultant formation of biofilm. For example, a single modern spa pool may contain as much as 75m of flexible and fixed pipework with a total available surface area of over 550m2. The use of flexible corrugated pipework is not recommended (see Section 2.5.1.1).

2.5.1.3 Manufacture

197. Most modern spa pools are manufactured from a seamless acrylic sheet, which is vacuum thermoformed on a specific workstation. This is then reinforced with laminated layers of fibreglass before drilling and plumbing. Full functional and water testing is carried out to ensure the spa pool operates correctly to its maximum capability and that safety standards have been met and recorded. During these tests it should be remembered that whenever a spa pool is filled - even unheated on

display with no prospect of bathers using it - the water should be disinfected as usual. Otherwise there is a risk of infection for people in the vicinity. Since it is virtually impossible to remove all of the water in the system after testing there is a risk of the spa pool being contaminated with Legionella and other infectious agents that could subsequently colonise the system before delivery. It is important, therefore, that the water used for testing contains chlorine (3-5mg/l) or another appropriate disinfectant, that as much water as possible is removed after testing, and that the spa pool is disinfected as soon as it is installed.

2.5.1.4 Construction

198. Spa pools in common use are either constructed in concrete or more commonly prefabricated in acrylic or fibreglass. Any of these may be fully or partially tiled.

199. The structural support for prefabricated commercial spa pools may be in the form of adjustable legs supplied by the manufacturer, brick supports built on site, or less likely, back-filled and concreted in. In every case, prefabricated spa pools should have minimal movement or flexing of the shell, as this will cause damage to the laminated construction.

200. Hot tubs, self contained (portable) spa pools and various other mainly domestic types of spa pool are available but are not suitable for the heavy bather use usually associated with public spa pools.

201. The design of a spa pool shell for commercial use will conform to one of two basic principles. Conventional (rim) types have the water level 150mm to 200mm below the top to accommodate the bathers. Overflow (deck-level) designs maintain the water level at a constant height while the excess water is transferred to a balance tank to be replaced as the bathers leave the spa pool. All new commercial spa pools should be of an overflow design.

202. Whichever type of spa pool is provided, its surface must be smooth and free from defects or projections and it must be easy to drain and clean. Overflow channels and balance tanks must also be accessible and easy to clean.

203. All steps into the spa pool together with the surrounding area should be of a anti-slip pattern. A handrail, that cannot easily be removed, should be fitted to assist bathers upon entry/exit.

204. Most balance tanks are manufactured from GRP, have smooth internal surfaces and fully removable lids. This is essential for cleaning, which needs to be done inside and out to help minimise the growth of infectious agents. Full access to the balance tank facilitates cleaning, which should be carried out whenever the spa pool is drained, to avoid build up scale or scum on the water line. If the balance tank is 'buried' beneath the floor around the spa pool, then there must be at least two entry hatches and the lid must be completely clear of the tank, otherwise the area will have to be managed as per the Confined Spaces Regulations 199743. See Section 1.1.5.5

for more information on working in confined spaces.

205. Balance tanks usually have level switches for minimum and maximum alarms etc and these may require access from outside the tank to facilitate replacement (level switches may be broken during cleaning). Care must be taken to ensure that there is adequate access to the tank surround.

2.5.1.5 Plant space and location

206. Ideally the water treatment plant should be located as near as practicable to the spa pool with suction and delivery pipe runs and chemical dosing lines as short as possible. External access to the plant room should be sufficient to allow for initial installation and refurbishment at a later date.

207. The plant and its associated maintenance may vary but sufficient space and easy access is required to ensure that all routine functions such as inspecting the treatment equipment and cleaning the balance tank can be carried out adequately.

208. At an early stage in planning the allocation of plant room space is important and should be considered along with requirements fo <r chemical storage and other plant maintenance.

209. Plant space and chemical stores should be provided in accordance with CIBSE guides56 and Chapter 18 of PWTAG's Swimming Pool Water Treatment and Quality Standards57.

210. The water treatment plant should normally comprise as a minimum

- balance tank;
- circulation pump(s) with integral strainers;
- medium rate filter(s);
- booster pump;
- aerator pump;
- automatic controller;
- disinfectant dosing system;
- pH adjustment dosing system;
- heat exchanger.

211. Where ozone generation plant is installed mechanical ventilation may be necessary to achieve 10 air changes per hour. Extract should be at low level and in accordance with HSE EH3858 and CIBSE TM21 Minimising pollution at air intakes59.

212. Chemical storage areas should be separate for acids, alkalis, and disinfectants. They should be lockable, dry, cool and have provision for heat and frost protection.

2.5.1.6 The water treatment system

213. For a commercial overflow spa pool water is drawn through the filters from the balance tank and circulated back to the spa pool. The balance tank is replenished from the incoming mains water supply, from water displacement arising from the introduction of bathers into the spa pool and from the low suction point. The water is continuously circulated, filtered and chemically treated (24h/day) and heated before being returned to the spa pool via the inlets. Water within the spa pool should be at such a level that continual overflowing occurs into the level deck channel creating an effective surface skimming action, this then returns to the balance tank. There may also be a secondary circuit that draws water from the spa pool footwell and reinjects it into the spa pool. The heater and chemical dosing units should be adequately interlocked to 'fail-safe' if the water stops circulating.

214. In domestic spa pools the water is drawn directly from the spa pool via a surface level skimmer to the filter and chemical dosing. Additionally a low suction point is used for the secondary circuit to feed water back into the spa pool via the jets.

215. All suction outlets from the spa pool should be duplicated to reduce the entrapment of hair or any part of the bathers' bodies and connected to more than one fitting. Fittings are also of an anti-vortex design for the same reason. It is not recommended that separate suction pipes be run to the plant room and valved but, if they are, it is essential that all suction valves are open while the pump is running to avoid deadlegs.

2.5.1.7 The balance tank

216. A balance tank is required to take up the displacement arising from bathers entering the spa pool and initially provides a source of backwash water. Ideally the balance tank should be free standing or part of the main spa pool shell. It is important therefore that the balance tank is correctly sized and located, and incorporates suitable and safe access for cleaning and maintenance purposes. The interior surface of the balance tank should be smooth to facilitate cleaning and disinfection, and the tank and spa pool should be easy to rapidly drain completely to facilitate cleaning. The tank should have a lid that can be easily cleaned on both sides. Both stand alone and cast in situ balance tanks should be fully enclosed and in both cases the lid or inspection hatch should be easily removable to facilitate access to the tank.

217. There should be sufficient water capacity within the balance tank when the spa pool is unoccupied to provide for a filter backwash. The backwash volume should be based on the flow rate and time period recommended by the filter manufacturer and should allow for all filters to be backwashed consecutively.

218. The average displacement allowance per bather is 0.075m3. The total bather displacement can be obtained by multiplying this allowance against the maximum bather capacity for the spa pool.

219. A low water level in the balance tank should cause the circulating pump to

stop automatically in order to protect the system.

2.5.1.8 Circulation

220. Intensively used spa pools should be designed with a surface draw off of at least 80% of the circulation volume. This is achieved by the installation of a level deck system. Skimmers are not considered to be suitable for heavily used commercial spa pool application. Pumps should be sized to provide a turnover of 6 minutes.

2.5.1.9 Filtration

221. Filters for commercial use will either be permanent sand filters or diatomaceous earth. When using sand filters care must be taken to ensure that sufficient water, whether from the spa pool, balance tank or both, is available for adequate backwashing as prescribed by the manufacturer. Diatomaceous earth filters require less backwashing than sand filters but managers should be aware that these filters require the regular replenishment of diatomaceous earth after backwashing, which can increase the maintenance and running costs. A simple means of adding the diatomaceous earth should be installed. It is not ideal to add this via the balance tank. Simple paper cartridge filters are not recommended for commercial spa pools, but are suitable for use in domestic spa pools. Highly efficient cartridge filters are now being produced for commercial use Ð see specialist advice for further information. Filter pumps will have a course strainer basket which must be examined daily, cleaned if necessary, and in any event cleaned at least once a week.

222. Commercial spa pools should only ever be designed on a minimum of a medium rate filtration ie 10-25m3/m2/h to enable them to cope with the high bather pollution.

223. Filtration rates of between 25 and 50m3/m2/h are only considered to be satisfactory for lightly loaded residential or domestic spa pools.

2.5.1.10 Heating

224. The operating temperature of the spa pool is normally in the range of 35°C to 40°C. The heat exchanger should be sized such that when raised with fresh water the temperature can be raised at a rate that will not involve thermal change sufficient to cause damage to the shell or any tiling. Specific details are given for tiled pools in BS 5385 Part 4 199260, which suggests a maximum rate of 0.25¡C per hour.

2.5.1.11 Chemical dosing and control systems

225. There are a wide variety of automatic control systems available incorporating either redox, amperometric or photo ionisation (PID) detectors. Both amperometric and PID controllers are more specific for chlorine and bromine, and are considered to provide better control than redox. It is essential that these are maintained following the installation of the controller. Care must be taken when considering the use of an automatic controller with Trichlor to ensure its suitability and compatibility with cyanuric acid.

226. Chemicals added to the spa pool water as a solution are normally added by positive displacement metering pumps. These can normally be adjusted to vary the volume of the chemical dosed per stroke and the number of strokes per hour.

227. Where chemicals are added as solid tablets such as trichloroisocyanuric acid (Trichlor), calcium hypochlorite or bromochlorodimethylhydantoin, they are introduced via a sidestream dispenser.

228. Many complex systems are used for testing and dosing spa pool water. Managers should familiarise themselves with their own system, understand the principles involved and the standards of water purification they are designed to achieve.

2.5.1.12 Booster jets

229. The jet or booster pump takes its water from the spa pool and delivers it directly back to the jets. The action of the water through the venturi in the jet creates a suction, which, when the air controllers are open, allows air to mix with the water to increase the massage effect. The air controllers may be sited on the spa pool or valved in the plant room. The pump is operated by an air switch near the spa pool or remotely by the attendant, an automatic timer should shut the system down after a short time, usually ten or fifteen minutes.

230. Ideally the pipework and certainly the jets should be readily demountable (the latter from inside the spa) and accessible for cleaning and disinfection.

2.5.1.13 Air blower system

231. Most spa pools also have an air massage system consisting of a series of air holes or injector nozzles in the floor and seats. An air blower delivers air to these outlets and is operated in the same manner as the booster jets. The air intake must be from a satisfactory source - warm air may be required.

232. The air holes in injector nozzles and associated pipework are often traditionally buried in the insulation and inaccessible. When the air blower system is not operating water will fill the air system up to the level of the water in the spa pool. Since there is no water circulation through the air system the disinfectant can rapidly become depleted. Condensation will also form in any pipework above the water level, encouraging the growth of biofilms and fungi. The air system can therefore become inadequately disinfected and act as a focus for the growth of infectious agents that are then difficult or virtually impossible to disinfect and remove adequately. This pipework should be designed to be readily demountable and accessible for cleaning and disinfection.

2.5.1.14 Spa pool water make up supply

233. In accordance with the Water Supply (Water Fittings) Regulations 199913 make up supply to the spa pool should be via a make up tank and not direct from the mains water supply. Ideally make up should occur directly into the balance tank and

the supply pipework should be sized to ensure that quick filling of the spa pool can be achieved upon draining. It is satisfactory to fill a spa pool from an adjacent swimming pool, but do not transfer the used water from a self-contained spa pool back into a swimming pool.

2.5.1.15 Location

234. Planning where to locate a spa pool is a key consideration in keeping the water clean. Allowing suitable access for maintenance cleaning and disinfection, for example, is fundamental to operating a spa pool within the recognised safety standards.

235. Of particular importance is the location and positioning of any balance tank. The balance tank should be located in a position that facilitates easy cleaning and disinfection, and key to this is ease of access.

236. Wherever the spa pool is located it is essential that a solid foundation be provided. If located outdoors the positioning of trees and gutters should be such that debris cannot readily fall into the spa pool. If the spa pool is to be placed indoors the room will need to be well ventilated as spa pools give off a large amount of moisture, which can damage walls and ceilings over time - dehumidification equipment may be required, managers should seek professional advice.

2.5.2 Basic design features

2.5.2.1 Design bathing loads

237. The design bathing load is the maximum number of bathers who use the spa pool in any one-hour, each hour consisting of three 15 minute bathing sessions followed by a five-minute rest period. The design bather load should be approximately ten times the capacity of water in the spa pool system when measured in cubic metres. Practical experience with a particular spa pool and a full risk assessment are needed to confirm that this bather load gives satisfactory water quality.

2.5.2.2 Water replacement

238. For stand alone commercial spa pools the SPATA standards42 recommend that the spa pool water should be replaced with fresh water when: The number of bathers = 100 x the water capacity measured in m3; or The number of bathers = half the water capacity measured in gallons. In heavy use commercial situations stand alone spa pools are likely to need draining and water replacement at the end of each day.

239. For spa pools that are incorporated with the swimming pool water treatment system dilutions of pollutants is much greater and the recommended standard for swimming pools of 30 litres per bather per day should be applied to the whole swimming pool and spa pool system combined.

2.5.2.3 Physical operation

240. With effective skimming and filtration systems, there should be a maximum water turnover time of 15 minutes for domestic spa pools, and a 6-minute turnover time for commercial spa pools. The turnover time is the time taken for the entire spa pool water volume to pass through the filters and treatment plant and back to the spa pool. Sand filters in commercial spa pools should be backwashed on a daily basis but in domestic spa pools fitted with sand filters the frequency may be reduced. Filters should always be backwashed before the pressure rises above normal clean operating pressure by 0.35bar (5lbs/in2). Diatomaceous earth filters should be backwashed and recharged according to manufacturers instructions. Domestic spa pool users are advised to keep two sets of cartridge filters to ensure there is one set available to use whilst the other is being cleaned.

2.5.2.4 Dehumidification

241. In considering the use of spa pools in commercial applications special attention must be given to the dehumidification/ventilation of the area around the spa pool. It must be realised that the level of evaporation from the surface of the spa pool, which is greatly increased the moment the jets/airblower are operated, is very high and probably much greater than any single equipment system can cope with economically. It is important to acknowledge this from the outset and to provide equipment systems/control that will lower the humidity when the spa pool returns to the quiescent condition. The following is a minimum requirement

• The use of 'control timers' to limit prolonged operation of the jets/airblower when the bath has been vacated. The timers usually limit the continuous operation to no more than 15 minutes.

• An air temperature of 1 degree C above the water temperature and a maximum relative humidity of 60-70% is typically required. Ventilation should be set at a rate of 10-15 litres per second per square metre of wetted area. Where outdoor air input is used as the only means of controlling humidity the chloramines are exhausted along with the humid air. Central plant incorporating heat recovery and/or heat pump dehumidification to allow recirculation of air may be utilised. However, the economies of such systems require detailed consideration and experience has shown that recirculatory systems, even those operating on ozone with residual chlorination, can operate under conditions that cause severe corrosion and loss of performance in a short timescale.

• The use of a cover overnight and at other times when the spa pool is out of use.

242. In addition, where the spa pool is very large or where it is operated in a confined space, a wall-mounted dehumidifier should be provided. This will not only provide a level of dehumidification but will also contribute to the space heating which will in itself help to reduce the formation of condensation.

2.6 Whirlpool Baths

243. Whirlpool baths are designed for one or two users and are intended to be filled and emptied after each use. Whirlpool baths are usually fitted with a few jets, which can be angled in use and removed for cleaning. In addition there is usually an air track in the floor of the bath, powered by an air blower system or alternatively air may be introduced to the water jets by the Venturi effect. As with spa pools the pipes and pumps associated with the water and air circulation system can become colonised and infections, particularly due to Pseudomonas aeruginosa have resulted from their use.

2.6.1 Design of whirlpool baths

244. The same design criteria should be applied to whirlpool baths as to spa pools. All water from pipework and air blower system should drain out with the rest of the bath water between uses. Pipes should be fitted so that they cannot sag and create pockets where water may remain between uses. Synthetic piping materials should be WRAS approved for contact with hot water. Flexible and corrugated pipes should be avoided. For ease of cleaning the jets should be readily removable and pipes easily accessible and removable.

2.6.2 In use hygiene and cleaning

245. Bathers usually use soap and water to clean themselves and sometimes wash their hair in the bath. The jets and air system should not be used when this soapy water is in the bath as it will tend to foam and leave residue in the pipes around the bath. Whirlpool baths are sometimes associated with beauty salons where skin treatments such as mud or seaweed may be applied. These should be washed off before entering the bath otherwise they may coat the insides of the pipes and encourage microbial growth.

246. The surface of the bath, like any other bath, should be wiped clean after use. In addition, although the whirlpool bath is designed to drain, there will still be damp in the pipework. Jets should be removed regularly Ð at least weekly on residential and daily on commercial (eg Hotel) whirlpools - and thoroughly cleaned, preferably washing off if necessary in a solution containing 10-50mg/L of chlorine.

247. In addition, and at the same frequency, the whirlpool bath should be filled with cold water and dosed at 20 ppm of chlorine for at least 2.5 hours to disinfect the system, and then drained, refilled and drained again. The water in the whirlpool bath should be generally free from black and other particulate matter after use of water and air jets: if not, then the cleaning regime needs to be repeated and may need to be carried out more frequently or otherwise modified.

248. The use of a proprietory whirlpool bath cleaner is recommended but care should be taken, by examination of the Material Safety Data Sheet to ensure that the surfactants etc. are suitable for use in contact with humans. Expert Advice may be required.

249. A number of commercial products are currently being developed and evaluated to improve upon those currently available whirlpool bath pipework cleaners. Such products are sold by hot tub and spa or swimming pool dealers.

2.6.3 Whirlpool baths in healthcare settings

250. Whirlpool baths are sometimes installed in health care settings. Advice should be sought from the local infection control team but extra precautions to ensure disinfection between uses are warranted and pools designed specifically for therapeutic use should be used. Baths with an air track embedded in the floor or sides of the bath should be avoided as such systems are difficult to disinfect adequately. Complicated designs should also be avoided as they are more likely to become colonised and are difficult to disinfect reliably. The disinfection regime applied to baths in health care facilities should be regularly monitored for its effectiveness by collecting samples for microbiological analyses just after filling the bath in the normal manner with fresh water. The frequency of testing and the microbiological standards should be the same as those recommended for spa pools.

2.7 Hiring and other commercial uses

2.7.1 Holiday Home and shared Spas and Hot tubs

251. A normal domestic spa or hot tub is designed for use by a family up to twice a day in a private residential situation. Where a spa pool is supplied for use at a holiday home (LET), it needs to have a continuous chemical feeder built into the spa to continuously treat it with disinfectant.

252. If there are a number of premises sharing a spa, then a commercial spa is required, preferably of a deck level (overflow) design with separate filter, and continuous chemical feeder system. Deck level spas require a balance tank which takes up extra space as well as a separate filter (usually sand or diatomaceous earth).

253. The whole system will need regular (at least weekly Ð depending upon bathing load Ð) shock treatment, drain down and cleaning (see sections 2.3.8 and 2.4.1).

2.7.2 'Party Rental' or 'Entertainment Spas'

254. Domestic spas are not designed for continuous bather use. If they are to be rented out for parties or similar occasions they need to be carefully managed. If the use is likely to be greater than for normal domestic use (see 2.7.1 above) a spa designed for commercial use should be used. Under section 3 of the HSWA, the responsibility of the hiror (the person providing the pool for hire) is to ensure, so far as is reasonably practicable, that the hiree and other users are not exposed to risks to their health and safety at the point of hire. The hiree should be given sufficient instruction to enable them to use the pool safely. After each period of hire the hiror should ensure that the pool is completely drained, cleaned, refilled, disinfected and

drained again. When stored, the pool including the insides of the pipework should be dry. Before hire it should be disinfected again. The hiror should confirm the effectiveness of the maintenance regime of the pools they provide for hire by routine microbiological testing.

Appendix 1 Audit checklists

1. The following checklists are designed to help the responsible person audit the arrangements that they have in place to control the risk of infection from the spa pools they are responsible for.

2. This is a check on the responsible person's knowledge of the system and also the knowledge of those who play a role in controlling the risk from the system, for example, water treatment contractors. There would be no value in asking a third party to complete this audit, because the responsible person should have been appointed because they have 'sufficient authority, competence and knowledge' of the systems in the workplace.

3. The checklists are not risk assessments. The checklists have been prepared on the basis that the employer has already identified that there is a risk system(s) in the workplace and that they need to put in place (or review) the measures that prevent or control the risks of infection. However, the first checklist addresses a number of issues relating to the risk assessment so that the responsible person can audit the assessment process itself.

4. The system checklist takes the user through the recommended measures in this guidance and the Approved Code of Practice and Guidance on the Control of Legionella bacteria in water systems (L8)5 so that the responsible person can audit the arrangements they have in place or intend to put in place. A negative answer to any of the questions indicates that there is a need to review the arrangements that are in place.

5. The checklists do not give guidance on how to achieve control, this should be done after consulting L8 and this guidance for detail on control measures and how they are put in place and monitored.

6. Using the system checklist requires a physical inspection of the system as well as examining the management procedures and paperwork in place and talking to those who may have responsibilities for aspects of the control regime.

7. The checklists only cover spa pools, the employer will also need to assess whether there are other sources of risk in the workplace and put in place appropriate control measures.

Checklist 1 -The risk assessment

1. Have you includedÐ

- Name of auditor
- Date of audit
- Date of review (see Checklist 1 question 9 below)
- Action required (list)
- Dates Completed

2. Did you consider whether you could eliminate the riskÐ

Note: Your primary duty under the Control of Substances Hazardous to Health Regulations is to prevent the risks of exposure, although this may not be possible when running a spa pool.

3. Have procedures been put into place to ensure that control measures being used are maintained, examined and testedÐ

4. Did the risk assessment consider the need to monitor exposureÐ

5. Did the risk assessment address the need to plan for foreseeable accidents, incidents and emergenciesÐ

6. Was the risk assessment carried with competent help and adviceÐ

7. If there are more than 5 employees in your organisation, did you record the significant findings of the assessmentÐ

8. Did you consult employees about the assessment and the control measuresÐ

9. Have you identified the circumstances, which would require a review of the assessmentÐ

Note: Your assessment should be reviewed regularly - at least every two years, and whenever it is suspected it is no longer valid, for example if there is a significant change to the system. Managing the risks - Roles and responsibilities

10. Has a 'responsible person' been identified in writingÐ

Note: If risks have been identified, there needs to be someone to take charge of managing the control regime.

11. Is there a nominated deputyÐ

12. Are contact details for these persons readily available (in the event of an emergency)Ð

13. Are the roles and responsibilities of all your staff involved in the control regime clearly defined in writingÐ

14. Have they all received appropriate trainingÐ

15. If external contractors are used, are their roles and responsibilities clearly defined in writingÐ

Note: The demarcation between contractor and occupier needs to be defined, ie who does what. But remember that using contractors does not absolve you of the responsibility for ensuring that the control regime is carried out.

16. Have you checked the competence of contractorsÐ

Note: For example, you should ask about experience and qualifications, how their staff are trained, and whether they are a member of a professional organisation / recognised trade body, for example the Legionella Control Association. You can find out about the health and safety performance of companies by checking HSEÕs enforcement databases (http://www.hse.gov.uk/notices and http://www.hse.gov.uk/prosecutions)

17. Have you considered all other health and safety issues (eg COSHH assessments for handling of water treatment chemicals, working in confined spaces, electrical safety and ease of access to parts of the system)Ð

18. Are appropriate records being maintainedÐ

19. Have you provided relevant health and safety information to users eg in the form of posters or noticesÐ

Checklist 2 - Spa pools

1. Record details of pools below (ie make, model, year of manufacture, type) - you should complete a checklist for each pool.

Managing the risks - The written scheme

2. Is there a written scheme for controlling the risk from exposure to disease causing micro-organismsÐ

Note: If your assessment has shown that there is a reasonably foreseeable risk of exposure to Legionella bacteria or other hazardous biological agents, there needs to be a written scheme in place to control that risk.

3. Does the scheme contain an up-todate plan of the system (a schematic plan is acceptable)Ð

4. Does the plan show

- all system plant, eg water softeners, filters, strainers, pumps, non return valves
- all standby equipment, eg spare pumps
- all associated pipework and piping routes
- all associated storage/balance tanks
- any chemical dosing/injection points
- origin of water supply
- any parts that may be out of use temporarilyÐ

5. Does the scheme contain instructions for the operation of the systemĐ

6. Does the scheme contain details of the precautions to be taken to control the risk of exposure to Legionella and other disease causing micro-organismsĐ

7. Does the scheme contain details of the checks that are to be carried out (and their frequency) to ensure that the scheme is effectiveĐ

Design and construction

8. If you are fitting a new system, do any of the materials or fittings used in the water systems support the growth of micro-organismsĐ

Note: The Water Research Centre publishes a directory, which lists materials and fittings acceptable for use in water systems. (www.wras.co.uk)

9. Are low corrosion materials usedĐ

10. Is all pipework accessible for maintenance, draining, cleaning and disinfectionĐ

11. Is the balance tank easily accessible for cleaning and disinfectionĐ

Operation and maintenance

12. Is the system in regular operationĐ

13. Are there procedures in place to operate standby equipment on a rotational basisĐ

14. Is there an operations manual for the spa poolĐ

Water treatment programme

15. Is there a water treatment programme in placeĐ

16. Are chemicals/biocides used to control microbiological activityĐ If no, list methods used below.

17. Are chemicals dosed automaticallyĐ If yes, are the pumps and associated equipment calibrated regularly (monthly)Đ

Note: Although there is no requirement for automatic dosing, you should consider issues associated with manual dosing - the health and safety risks, for example manual handling and exposure to chemicals, to staff who carry out manual dosing as well as the management of the process to ensure that the frequency and rate of application are maintained.

Monitoring

General:

18. Are the safe operating limits for each parameter, which is being measured, known and recorded in the operating manualĐ

19. Is the corrective action for out of limit situations known and included in the operations manualĐ

20. Are results of all tests and checks recorded, together with details of any remedial action taken (if required)Ð

21. Is there a daily:

• check to make sure that the system is operating as described in the operations manual

• check made of the cleanliness of the water in the system

• back-wash of the sand-filter

• clean of water-line, overflow channels, grills, and spa pool surroundÐ

Biocides

22. Is the control level required known and recorded in the operations manualÐ

23. Is the rate of release/rate of addition of biocide known and recordedÐ

Microbiological

24. Are microbiological tests for indicator organisms carried out on a monthly basisÐ

25. Are samples for Legionella taken on at least a quarterly basisÐ

26. Are all microbiological results recorded so that trends over time can be seenÐ

27. Have the circumstances when more frequent sampling may be required been identified and recordedÐ

Cleaning

28. Is there a written procedure for regular cleaning of the systemÐ

29. What is the frequency (see sections 2.3.8 and 2.4.1)

30. Have the circumstances when emergency cleaning and disinfection of the spa pool been identifiedÐ

31. Are procedures in place for chosen method of cleaning and disinfectionÐ

Appendix 2 Trouble shooting guide

DO NOT ADD CHEMICALS TO SPA POOL WATER BY HAND DOSING WITHOUT HAVING RECEIVED PROFESSIONAL ADVICE AND THEN ONLY WHEN THE SPA POOL IS NOT BEING USED FOR BATHING.

Issue	Remedial actions
pH out of limits (ie less than 7.0 or greater than 7.6)	Close spa pool and check acid/alkali dosing units (ie operation and calibration). Recheck pH once any faults have been rectified. If pH is still out of limits, pool will need to be emptied and refilled with mains water to reach pH 7.2 (NB additional disinfectant may need to be added to achive this pH.)
Disinfectant out of control limits (chlorine<1mg/l or >5mg/l; bromine<2mg/l or>6mg/l	If below minimum concentrations required for control, close spa pool and retest using dilution technique. (Also close if chlorine/bromine exceed 10/12mg/l respectively; for levels between 5/6 and 10/12, retest). Check dosing units (including calibration of automatic controller if fitted) are working properly eg they contain adequate disinfectant, flow rate is appropriate, there are no kinks/air locks/blockages in pipework. High levels of disinfectant can be lowered by partial replacement of pool water, once the underlying fault has been rectified.
Cloudy spa pool water	Close the spa pool and check operation of: • circulation pump, • sand filters • disinfectant dosing unit., and • pumps If cloudiness is as a result of excessive microbial growth, pool will need to be shock dosed with chlorine before being bought back into operation. Any algal deposits will also require physical removal.
Dirt/grease around overflow channels	Ensure that affected areas are cleaned on a regular basis with appropriate cleaner that is compatible with water treatment chemicals used
Presence of hardness salts on overflow channels and spa pool surrounds	Check pH control of water (ie is this consistent over time), and seek further specialist advice. Presence of such deposits may also be as a result of hand dosing of water treatment chemicals. This should not be carried out without proper advice.

Appendix 3 Spa pool water testing procedures

(Note: if testing is to be carried out using a comparator the person conducting the tests cannot do so if they are red/green colour blind. All staff using such equipment should be tested for red/green colour blindness.)

These tests should be done daily before use (domestic spa pools) or on a regular basis throughout the day (commercial spa pools and domestic/commercial spa pools on display) using the following procedures. Note: ManufacturerÕs instructions should always be carefully followed and only the correct manufacturerÕs reagents should be used with each kit; do not mix and match.

Testing for residual disinfectant concentrations

Total active bromine

Bromine can be determined using a suitable comparator and standard DPD No. 1 test tablets.

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Rinse out plastic cell marked DPD with spa pool water.

2. Add a small amount of spa pool water to be tested to the cell, so that it just covers the bottom.

3. Add one standard DPD No. 1 test tablet to the DPD cell, without touching the tablet, by carefully tearing the foil.

4. Crush the tablet with the crushing rod, and mix with the small amount of water already in the cell. (Watch out for colour developing/disappearing as this will indicate whether bleaching out is occurring.)

5. Fill the cell, with the water to be tested, up to the 10ml mark and stir contents gently with the rod.

6. Place the cell in the right hand compartment of the comparator (with the viewing glass facing you).

7. Fill the empty cell with the spa pool water to be tested and place in the left hand side of the comparator.

8. Read at once against the blank using a standard bromine disc (covers the range 1-10mg/l).

DESIRED RESULT 4-6 mg/l

If the colour forms and then disappears as the water is added, if no colouration develops, or a reading of 10mg/l or above is obtained then bleaching out of the colour may have occurred and a further test must be undertaken once the spa pool water has been diluted.

Dilution test:

Pour the sample of spa pool water to be tested into a measuring vessel. Add a volume of mains tap water equivalent to 3 X the volume of the sample. Put the lid on the vessel and shake it. Carry out the DPD1 test for active bromine using this solution.

The dilution described results in a 4-fold dilution of the sample. The reading obtained should therefore be multiplied by four to give you the residual concentration of active bromine in the spa pool water.

If the active bromine concentration is still high, it may be necessary to carry out a further dilution. i.e. X 6 (1 part spa pool sample + 5 parts of mains tap water) or X 8 (1 part spa pool sample + 7 parts of mains tap water) to provide a reading within the scale.

Eg if a comparator reading of total bromine of 2mg/l is obtained on a sample diluted X 4, then the true value of total bromine in the spa pool water is 8mg/l.

Free chlorine

This may also be estimated using a suitable comparator and appropriate DPD No. 1 test tablets:

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Rinse out plastic cell marked DPD with spa pool water.

2. Add a small amount of spa pool water to be tested to the cell, so that it just covers the bottom.

3. Add one DPD No. 1 test tablet to the DPD cell, without touching the tablet, by carefully tearing the foil.

4. Crush the tablet with the crushing rod, and mix with the small amount of water already in the cell. (Watch out for colour developing/disappearing as this will indicate whether bleaching out is occurring.)

5. Fill the cell with the water to be tested to the 10ml mark and stir gently with the rod.

6. Place the cell in the right hand compartment of the comparator (with the viewing glass facing you).

7. Fill the empty cell with the spa pool water to be tested and place in the left hand side of the comparator.

8. Read at once against the blank using a standard chlorine disc (covers the range 0.5-6mg/l).

DESIRED RESULT 3-5 mg/l

At high concentrations of chlorine bleaching can occur. If no colouration develops, or a reading of 6mg/l or above is obtained a further test must be undertaken after diluting the spa pool water (see previous test for details of how to do this).

Total and Combined Chlorine

These are measured using a standard comparator and DPD No. 1 and DPD No. 3 test tablets (or a DPD4).

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Determine the free chlorine concentration as above.

2. After recording the disc reading add one DPD No.3 test tablet to the free chlorine test solution and crush to dissolve. Allow to stand for 2 minutes.

3. Place in the right hand compartment of the comparator and read against a standard chlorine disc.

The second reading represents the total residual chlorine concentration.

By deducting the free chlorine reading (DPD1) from the total chlorine reading (DPD1 & DPD3), the combined chlorine concentration is determined.

Note: if a total chlorine reading of 6mg/l or more is obtained then a dilution test is required.

The ideal combined chlorine value is nil, but up to a value equivalent to 1/3 of the total chlorine would be acceptable.

pH using a comparator and phenol red tablets

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Fill the plastic cell marked pH to the 10ml mark with water to be tested.

2. Add one phenol red tablet and crush with the rod and stir gently to thoroughly mix the solution.

3. Place the cell in the right hand compartment of the comparator (with viewing glass facing forward).

4. Fill the empty Phenol Red cell with spa pool water to be tested and place in the left hand compartment of the comparator.

5. Compare the colours using a standard phenol red disc (covers the range 6.8-8.4)

DESIRED RESULT 7.0-7.6

If the result is equal to or lower than 6.8 or equal to or greater than 8.4 this test will not be able to give an accurate value. To obtain a more accurate pH value the spa pool water will need to be adjusted using sodium ash/sodium carbonate if the pH was low or dry acid/sodium bisulphate if the pH was high, to bring the readings within the desired range.

Cyanuric acid using the Twin Tube test kit

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Separate the inner and outer tubes and fill the outer tube to the top black line with spa pool water.

2. Add one cyanuric acid tablet to the water in the tube and crush with the rod.

3. Place the lid on the tube and shake until the tablet has dissolved completely.

4. Insert the square graduated tube into the outer tube and then viewing from the top, move the inner tube up and down until the black spot in the bottom is just no longer visible.

5.Read the graduation marks on the inner tube at the level with the top solution in the tube. This figure gives the concentration of cyanuric acid present in the spa pool water.

If the figure is found to be between 80 and 100mg/l, repeat the test in the following manner:

1. Fill the outer tube with spa pool water to the bottom line.

2. Using tap water, fill the outer tube to the top line.

3. Continue the test using the procedure described above.

4. Multiply the reading by 2 to give the final concentration of cyanuric acid in solution.

If the initial reading prior to multiplication is still between 80 and 100mg/l, then further dilutions of the sample should be made.

THE CONCENTRATION OF CYANURIC ACID IN THE SPA POOL WATER SHOULD BE MAINTAINED BELOW 200mg/l.

Please note:

- DPD No. 1 test tablets are slightly poisonous and should be kept out of reach of unauthorised personnel, and stored under cool conditions. (Please refer to the Material Safety Data Sheet [MSDS] with the tablets for more information on how to use safely.)
- Water containing DPD or phenol red tablets should not be poured into the spa pool but flushed down an external drain.
- All testing equipment should be safely stored when not in use.
- The DPD and pH cells should only be used for the specific test as mixing the cells can give rise to false readings, even when the cells are regularly washed out.

Photometric and other test kits are commercially available. All testing equipment should be kept clean and well maintained.

Manufacturer’s instructions should always be carefully followed and staff should receive sufficient information, instruction and training in order to undertake any testing in a competent manner.

Ek-4 : Cyanurics - Benefactor or bomb?

"If we put enough of this stuff in the pool,
maybe we won't ever have to add chlorine!"

The following paper is an adaptation of two technical articles of the same name appearing in the Pumproom Press, official publication of the PPOA. The material was written for advanced pool operators, not academicians, and should be viewed accordingly. It may not be reproduced in part for any reason, however permission is granted to copy the entire paper in small quantities for educational purposes, or for inclusion in JSPSI, as long as the author, the publication and the organization are fully credited.

PART I

Cyanuric acid ~ Valuable, magical, beneficial, profitable... misunderstood, misrepresented, problematic. These all apply, and more. This chemical pool additive may very well be the most controversial topic in the industry today. Indeed, you will hear more diverse advice from pool professionals, "experts," dealers, even from university and corporate chemists, on the subject of chlorine stabilization than on anything else in the world of pool-water chemistry. Maybe it's time the subject is reviewed from a reasonable, unbiased standpoint so well-read pool operators can be the knowledge leaders, not the misled.

Now this stuff is truly a miracle worker for the busy backyard pool owner and for the residential pool service tech. Hotel/motel operators with low-to-moderate-load pools find great value in the product. And it serves many public-pool applications very well too. In other busy public pools, however, misused stabilized chlorine performs quite poorly, hence industry concerns. Responsible training, in-depth investigation and appropriate, conservative use are necessary keys to unlocking the considerable benefits offered by CYA. Is cyanuric acid the right choice for your poolĐ Where can we look to find out...

With little common ground of agreement, even some district and state health departments are providing confusing guidance. In some cases, inspectors are prohibiting the use of cyanuric stabilizers in any of their public pools, while others have actually been insisting on its use. Still others say a pool operator must use at least 30 ppm if she or he chooses to use CYA at all. Among those sanitarians requiring it, there have been a few who did so even in cases of indoor pools! If the paragons of public health and safety can't agree, we begin to wonder how they expect public-pool operators and other common folk to get it right!

Most health departments deserve acknowledgment for seeking their own pool-related training and becoming technically knowledgeable in recent years, nonetheless the very sources for such technical guidance on cyanuric acid and its use are themselves inconsistent and, often, inaccurate. Claims abound: It makes your chlorine last ten times longer. You get better use out of your chlorine. Chlorine's more powerful with it. It balances the chlorine. Water is not balanced without it. Chlorine doesn't work without it. The law requires it... And the these claims become the essence of the "technical" advice or training provided by people with a financial interest in the promotion and use of cyanuric acid. This material creates a three-hundred- million-dollar-a-year industry, which tells us a few things - it's been a successful endeavor, there's plenty of motivation to continue promoting it, and it's not going away!

Surely you know that "what is right" for you and your pool may be quite different than what's right for someone else and his. As life is full of trade-offs, certainly this CYA business is no exception. While shifting through a car's gears we trade power for speed; in an electric transformer we trade voltage for current; when we restrict hydraulic flow with a valve we trade volume for pressure... In the case of pools using "stabilizer," we simply trade activity for longevity.

This trade off, while intolerable or inappropriate for some users, is what's so miraculous for others. Sometimes we need all the "activity" we can get. Much of the time, the longevity is more important. Just remember, you don't get somethin' for nothin' in this world. There is simply "no free lunch"!

CHARACTERISTICS: Like so many other products and chemicals around our pools, there's a number of names for this material, all identifying the same thing. Most pool folks use the official name - cyanuric acid - or, more commonly, cyanurics. (It's s-triazine trione in chemspeak...) Stabilizer, even "conditioner" are frequently used terms by the layman, as well. (This author considers the latter an irresponsible label, designed purely to sell product to the uninformed.) CYA is the common abbreviation. The term chlorinated isocyanurates or "isos" means more than CYA alone, it refers to one of two stabilized forms of chlorine or cyanuric-bearing chlorine (di-chlor and tri-chlor), discussed below.

CYA is an acid, as the name implies, but a rather weak one. It is sold in a white, dry granular form, fairly slow to dissolve. It produces a pH in concentrated solution of about 4.0; but, in the dilutions typical of pool applications, CYA has little pH effect on that large body of water.

It is "pure stuff," in other words full-strength material, not compounded or mixed with other chemical products; that makes dosing rather easy. A pound of CYA in a million pounds of water is, plain and simple, a part per million. Remember that handy figure of 120,000 gallons which weighs in at almost exactly a million poundsĐ Ten pounds of cyanuric acid is ten parts per million. That's a fairly common pool size, too, but if your pool is larger or smaller, you can factor up or down rather easily.

Cyanuric acid is not consumed in its beneficial work; once CYA is in there, it's in there to stay. Only dilution by replacing drained or lost water can reduce the CYA level. (An awkward exception is mentioned later...) Another good news/bad news story, one finds the complete elimination of CYA nearly impossible. Even if the pool is completely drained, a little always shows up in the refill. Interestingly, it was this phenomenon which confirmed, at the University of California at Davis, that a virtually non-measurable two or three parts per million cyanuric acid does, no matter what the guys who sell it say, make a significant - over 30% - savings in chemical costs!

Cyanuric acid is often described by well-meaning authors in extremely technical terms, picturing the molecular-structure diagram of the "enol form" complete with carbon ring, bonds, atomic strings, molecular weights and more. An advanced degree in organic chemistry would be nice to understand such material; otherwise, it's over everybody's collective head. Beyond being non-valuable information, it is simply inappropriate to include such chemistry detail in material targeted at everyday folks, especially when, invariably, the same article will contain weak generalizations, excessive over-simplifications and inaccurate parallels. "Sunglasses for chlorine" comes to mind, as well as that list of claims enumerated above. "Tiny little time pills", silly as it sounds, is actually a pretty good analogy...

Somewhat simplified, the CYA molecule in water forms a weak and temporary "bond" with the chlorine ions in the water, during which time the ultraviolet energy from the sun can't easily degrade the measured "chlorine" residual. If you could "see" into the microscopic world of H2O, you'd find most compounds in water are in a constant state of change, as is our old friend hypochlorous acid (HOCl). This active compound comes and goes, as it ionizes (into OCl- and H+), "associates" back into HOCl again, attaches to and becomes released by CYA, kills tiny organisms, oxidizes all manner of organic flotsam and jetsam, maybe even combines with ammonia... Ultimately, it is either lost to dissipation/degradation or is consumed in the noble performance of those two distinct and critically important duties: oxidizing and disinfecting.

That's a lot of goings on! The truth is we don't really much care about all the hi-tech details, as long as we know how it all works out. Results are all that count, and if we get those two important items accomplished - oxidizing and disinfecting - we should be pleased. Without CYA, the chlorine better get to work fast, because it won't be around long. With the stabilizer, the "bonding" of chlorine in a protected state affords much more time for at least some level of this work to be done before chlorine fades into oblivion. Sanitary water that's crystal clear and non-irritating - if we get this result, the method we used to get there works just fine!

VALUE VERSUS RISK: So what's the rub; where's that tradeoffÐIs there a problem hereÐLet's look at a few (some hotly disputed) basic facts:

1. Isocyanuric acid helps chlorine "last longer" in pool water.

2. The "stabilization" of chlorine significantly reduces its work

value, its ORP.

3. Cyanuric acid always costs money, sometimes saves money.

No-one will disagree with item number one. And, with the reader's permission, let's decide upon the bottomline economy in Part II, as we sum up this paper's contents. That leaves the second item, which needs examining a lot more closely.

HOCl is inherently unstable, as we've all been taught. It is a real performer for that very reason. So what happens when chlorine is made more "stable"ĐThe more stable or unchangeable a compound is, the less performance one might expect from it. Take a glance at common salt, sodium chloride, for example. It's about the most stable chlorine compound on earth. In water, salt (NaCl) doesn't oxidize, it doesn't disinfect, it just drifts around in there being stable!

Assuming the validity of the "facts," above, we might reason that higher levels of chlorine might help offset the detracting effect of the stabilizer. Indeed, most health departments require higher residuals when using stabilizer, which tends to bear out this belief. One concern that prompts authorities to raise the minimum level of chlorine is the false sense of security created by longer lasting residuals, while reduced effectiveness of the lower value may approach the danger threshold - where oxidation or even sanitation problems are likely to arise.

Additionally, the much touted savings afforded by stabilization - the net reduction in chlorine consumption - are somewhat offset by the cost of the CYA itself (both initial dose and make-up additions), and the required maintenance of higher residuals of chlorine. Then all savings bets are really off if clarity problems arise, algae gets a solid foothold, or the pool is closed due to an unacceptable bacteria count. CYA could get expensive!

All is not lost, however.

EFFECTS ON OXIDATION & DISINFECTION: If a little is good, than a lot must be betterĐ

There is a point of diminishing returns with respect to the percentage of so-called stability, or "staying power", achieved as stabilizer concentrations are increased. It seems reasonable that if we stay below that dosage point, cyanurics are sure to be useful - even in some busy outdoor institutional pools. But what dosage pointĐ To determine some practical guidelines, exhaustive tests were run by a major manufacturer and other interested parties in 1984/6 - first in the Hall of Fame pool in Florida then at the

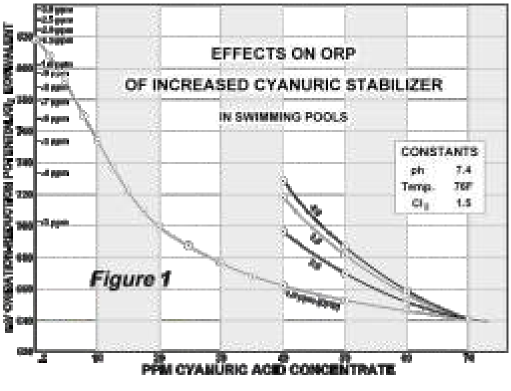


Figure 1

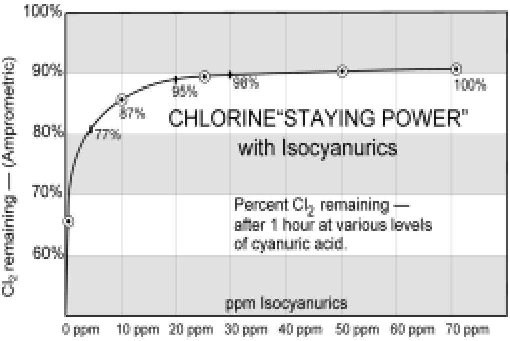
University of Hawaii competitive pool. This field work was followed by a detailed study in a controlled environment, where sensitive laboratory instrumentation corroborated the findings: Oxidation-reduction potential (ORP), considered the best means of evaluating chlorine's work value, falls off dramatically at a rapid and predictable rate as the CYA level is increased. This loss of "work value" can be stated, and plotted, in terms of equivalent free chlorine.

Referring to the chart above, we can see that at just 5 ppm CYA (pH at 7.4 and "free" chlorine residual 1.5 ppm - both held as constants), the equivalent chlorine effectiveness is more than 35% reduced! At 10 ppm CYA, the loss is 65%; at 20 ppm CYA the chlorine's equivalent effectiveness is down a startling 80%! Beyond 25 ppm CYA we can expect, in terms of oxidizing power, about 10% more in additional losses with very little gain in retention (see Figure 2, below). This is the case, no matter how high you go -- a classic case of diminishing returns!

"Aw c'mon, how can that beĐ" you ask. "I know of pools with twice that much cyanuric acid. Their water's clear, and the health guy says the plate count for bugs is OK..."

Remember what we are comparing: Potential to oxidize. If you don't need it all, you don't use it all and you're ahead of the game for a moment. In any pool, if the first .1 ppm can handle all the bugs, it does. If the next .3 or .4 ppm can handle all the organic contaminants, it does so as well. The rest shows up on the test kit as "residual" - that which is left - ready to do more useful work or, sadly and more likely, to decompose by the bombardment of sunlight.

Now add some stabilizer. The residual sticks around, appearing to be available to work. But the trade-off takes its toll. We've lost most of the power of the "insurance residual", that standby power of excess, measurable, active chlorine. Well, if this pool's out in front of a mom-and-pop motel with four swimmers a day, what little ORP is left will work just fine. Just stir in the football team after the Saturday game, a basketful of leaves or a dead cat, however, and see what you've got! This pool needs more than it's got, and you lose. You'd be asking that well-taxed 1.5 ppm, acting as if it were only .3 ppm, to handle half-a-part-per-million of ammonia. Not a chance...



You're paying the premiums on that insurance residual, so you might as well have the benefits... or most of them. Cyanuric use, balanced against experienced and predicted loads, is a tricky exercise reserved for the experienced pool operator who knows the consequences of too much stabilizer. Phoenix in the summerĐ Sunny, busy poolĐ Try ten parts per million or fifteen. Pool's not automatedÐTry up to 20 ppm. Walk that tightrope between demand and retention; the rewards are worth it. But, with so much less CYA than the guy at the pool-supply store recommends, will it really last longerÐ

With all this conversation on the ORP fall-off and lack of work value, let's examine just where we really stand on staying power, that ever-so-sought-after chlorine retention. We can't find our diminishing-return point without knowing what increase in residual lifetime to expect. Look at figure 2. (The data was extrapolated from public, technical bulletins of a major specialty chemical manufacturer, based on their in-house research.) This chart shows reasonable retention achieved with only 5 ppm CYA in use. Over 80% of all the retention potential available is achieved at 10 ppm, while values much over 20 ppm CYA exhibit diminishing returns, soon appearing beyond the cost-effectiveness threshold. These are not exactly the numbers you see advertised...

Another surprise: As effectiveness (in terms of ORP) is lost with rising cyanuric concentration, a flattening of the curve occurs around 70 ppm CYA; here's where no appreciable additions of chlorine will make any difference in the resultant level of ORP! Look at the three short curves in Figure 1 as they converge at about 12% of the original work value... no matter if you have 2, 3, 4 ppm chlorine or lots more! Stated simply, as CYA exceeds 70 ppm, virtually any level of chlorine will result in no more than about .2 ppm equivalent effectiveness. Longer lasting, yes. Better working, No. Levels of cyanuric from that point upward make any quantity of chlorine a pretty bad investment.

At much over 50 ppm CYA, controllers are a bad investment too; and as the water approaches 70 ppm CYA, controllers of ORP (the principle behind virtually every pool-chlorine automation device on the market today) simply quit - dead. If ORP won't rise when you pump the sanitizer into the pool, these systems won't meet set-point and wont turn off. Any claim to the contrary is simply false. (Try it in a bucket someday..!) All controllers will function OK at low levels of CYA (if you lie to the circuit by up-calibrating to compensate for the lost ORP) and none of them works at high CYA. Period.

Having investigated oxidation fall-off and "staying Power", what about disinfection - bug-killing powerÐ We don't want anything alive in the pool but the kids, so sanitizing is generally the variable of greatest concern. And this is where stabilized chlorine gets its highest marks, too. While so much disagreement is found among the pros regarding this often-studied sanitation aspect, we all have to admit - if a bug dies in one-tenth of a second or in ten seconds (100 times slower) it's still a dead bug! Looking at the pair of curves in Figure 3 (published in Applied Microbiology back in 1966), however, a very tough-to-knock-off bug named pseudomonas auruginosa (hot-tub itch) takes an unacceptably long time to die with low chlorine residuals under stabilized conditions. You'll note the researchers didn't use levels of chlorine now commonly suggested for spas but lower values allowed in the early days of CYA use. (You will have to concede, however, these levels are still found every day in spas and pools by environmental-health specialists all over the country.) At 70 ppm, a CYA level all too commonly reached or exceeded in public spas and pools, a half-part per million takes 20 minutes for the desired 99.9% kill, and 70 minutes at .1 ppm! Either value of chlorine could kill this pathogen in 5 to 20 seconds if not impaired with cyanuric acid.

Most pathogens are much easier to do away with than pseudomonas. Kill times are often extremely short, even in the presence of stabilizer. The experiments above were done in“unstressed” laboratory water, while more true-to-life conditions have shown a few bacteria appear to die even more quickly in the presence of CYA! Nonetheless, in exhaustive tests based on even the easiest to kill bug of all, coliform, levels of ORP under 650 mV (millivolts) could not be relied upon to produce satisfactory kill - and CYA was the regular and dominant negative influence in this impaired capacity to sanitize. (See details in Part II.) Even the World Health Organization has established 650 mV to be the minimum safe ORP for sanitary water

So stabilized pools, generally, remain safe from a health standpoint until ridiculous levels of CYA accumulate. Resultant water conditions don’t appear to change for the worse until the demand threshold exceeds the greatly limited “insurance” ORP. Then the first thing to go is clarity. Second, if the conditions are right, comes severe and un-yielding algae. A distant third is unacceptable sanitation.

So when and how muchÐWhen chlorine demands and costs are out of hand due to hot, sunny outdoor conditions, when the organic load in the pool is moderate to low, and when the operator is trained and has time to more closely monitor water conditions, stabilizing may be in order. Establish levels of 5 to 12 ppm CYA, or a little more, for your outdoor automated pool. Allow 20 ppm or so to provide good retention in a manually treated pool. Don’t EVER use CYA or stabilized chlorine in an indoor pool, and, even outdoors, please don’t use as much as the guy who’s selling it suggests...

There’s much more to discuss, so check CYA Part II. We need to look at stabilized chlorine products - their value and their drawbacks, more on what motivates the CYA information sources, why testing is a problem in itself, how the Oregon Study on ORP applies, and what the Pinellas County Study misses... followed by a 24-item bibliography in support of this opinion.

Part II

Having covered in Part I cyanuric acid’s significantly depressing effect on oxidation (ORP), it’s resultant improvement in residual “staying power” and its slowing of pathogen deactivation, we should be able to wrap up the conversation here. As the hazards and drawbacks of stabilization continue to unfold below, we won’t lose sight of the fact that cyanuric acid is an extraordinary product which serves the industry well when responsibly promoted and used.

ORP LOSS AND THE OREGON STUDY: To begin again, we will expand on a study alluded to in Part I, illustrating oxidation/reduction potential's unique value as a measure of a disinfectant's quality as well as potential to oxidize. However unplanned, that very same research illustrates convincingly that excess CYA is trouble with a capitol T in public-spa water. We should examine Dr. Brown's report in the context of CYA use and misuse.

Quoting from PrP issue 5 (ORP and Oxidation) where the research was detailed: "...In this remarkable study, thirty public spas were examined for all normal pool variables, plate count (bacteria density) and, finally, ORP. Extremes showed up in pH from 5.7 through 8.3, combined chlorine from 1.4 to 34 ppm, free chlorine from 0 to 30 ppm, cyanuric acid (what's it doing in a spa anywayÐÐ) from 0 to 1,300 ppm, plate counts from 0 through 15,000, and even Pseudomonas up to 12,400! The only correlation that stood up throughout the study was the relationship between ORP and the presence of pathogens. Virtually no plate count existed in the spas where ORP values were found to be above about 630 millivolts, while lower values, no matter the free chlorine residuals present, all had dangerous or near-dangerous levels of pathogenic life.

Among the unsafe pools in the study, chlorine residuals bore no resemblance to the plate-count values. Even when the free chlorine was as high as 4 ppm, a significant plate count existed because the ORP in that spa was 537 mV. The pH was 6.9, so why was the ORP so low in that spa's waterÐ Excessive cyanuric acid was the culprit, as was the case in all but two of the thirteen spas exhibiting ORP levels at or below 630 mV..."

This famous study corroborated other less known works and even the German DIN Standard, all establishing or confirming ORP thresholds and reasonable, universally recognized, standard values. An ORP level in water of 650 mV is the most widely accepted minimum for qualitative results, worldwide.

650 mV of ORP can be achieved with a variety of chemical compounds, conditions, and influences. It is "qualitative". 650 mV is the same working value whether it takes only .1 ppm "free" chlorine at pH 7.2 with no CYA to get there or 3 ppm at pH 8 in the presence of 30 ppm CYA to make it. In the second of these two extreme examples it takes 30 times more chlorine to achieve the same results. All it took was a pH elevation and the addition of cyanuric acid. Amazing...

Is 650 mV some kind of absolute drop-dead valueÐOf course not. Surely 620 mv or 640 mv will do the job under most conditions, sanitizing well and oxidizing adequately; the point is that 450 mV won't do it - and that's an easy low to arrive at with excessive CYA.

The Oregon study's most valuable conclusion was that no variable found in pools - not pH, free chlorine residuals, clarity, CYA, TDS, chloramine, none - could be linked to bacterial plate count. Only ORP was consistently reliable in predicting the sanitation of the body of water - above 650, consistently safe water; below 650, usually unsafe water. ORP is key, irrespective of the absence or presence of cyanuric acid or any other enhancer or detractor of chlorine. Yet ORP is exactly what cyanuric acid depletes.

Without stabilization, ORP levels well over 800 mV can easily be achieved with .9 to 1.0 ppm of free chlorine at pH 7.4, a work value which is knock-'em-dead generous. (See the ORP nomograph, PrP Issue #5, page 5.) This level of oxidation potential is simply un-achievable if stabilizer is present, however, at any practical residual of chlorine. If you need the ORP to handle consistently high organic loads in your pool, stabilization starts to look more expensive!

Over the years, many other "research" papers, articles and opinions have been written on the subject of stabilization. Most are favorable, even expressing unmitigated praise for CYA. Yet virtually every author writing positively about CYA addresses the subject of longevity and water sanitation only, with little or no concern (or even acknowledgment) for oxidation. The recent Pinellas County (Florida) CYA study is an excellent example of such incomplete work. A scholarly study, numerous and varied pathogens were summarily deactivated under even more numerous conditions of residuals and stabilization. The results were just like so many other sanitationonly reviews, quite positive. We already knew that bugs will die. C'mon, guys, that's the easy part. Get it together and do a study on organic oxidation and ORP in the presence of CYA, not give us more talk about sanitation. At least own up to the existence of this critical, unacknowledged variable. We can't stress enough that the two processes are different, and success in the bug-killing arena does not presume adequacy in oxidation, where its absence assures cloudy water, algae, and short filter cycles. As sanitation is so easy to come by, evaluating oxidation must be fundamental to the review of any sanitizer or stabilizer.

STABILIZED CHLORINE PRODUCTS: While the two common stabilized types of chlorine can't be covered exhaustively here, a some description of dichlor and trichlor and their use and misuse is necessary to complete this CYA inquiry.

Sodium dichloroisocyanurate (dichlor), a granular, stabilized chlorine product, is commonly sold for hand-feeding of residential and, sadly, public pools. It is promoted as "pH neutral". In fact, however, it is slightly acidic, producing a pH in a 1% solution of about 6.0. Unless your make-up water has a high pH, or some other high-side influence exists, your use of dichlor almost always requires some alkalizer (high pH material) for pH offset. Dichlor's cost is higher than most other chlorine products, but it is handy for small-pool users and is easily hand fed.

Dichlor should not be used as the routine sanitizer for public pools, mainly because it must be hand fed and most health departments require automatic feed systems. Moreover, caution has to be exercised when dichlor is used more than infrequently to avoid undesirable accumulations of CYA over time; by weight dichlor is 57% cyanuric acid! You'll be stuck draining the pool because you used too much of that high-priced chlorine for too long.

Dichlor is said to have a "62% available chlorine content" which means 1.6 pounds of this material in 120,000 gallons - a million pounds of water - yields a residual of one part per million. (One pound of elemental gas chlorine would yield the same, so divide 1 by 1.6; you'll get the advertised 62%.)

Dichlor is even promoted as an algaecide, usually under a disguised name at an elevated price. It will help kill algae, (maybe even that allowed to bloom because of excessive stabilization,) but so will the inexpensive chlorine products. True algaecides are a better bet for your money.

Use of Dichlor for superchlorination should be avoided as well, because of costs and the rapid CYA accumulation. Nonetheless, it is sometimes packaged and profitably sold for this very purpose. This is the last product you should use for superchlorination!

Moving on to trichloroisocyanuric acid, most often sold in tablets or sticks, we find a product that has grown immensely in popularity because it is idyllic for "erosion feeder" use. These simple plastic feeders are very inexpensive hence their proliferation; as they allow the hard-compressed, low-solubility tablets to dissolve slowly and continuously into a sidestream. ("Floater" feeders, the ultimate in cheap simplicity also based on the slowdissolving principle, are found in many private-sector pools. They are generally not accepted by health departments, however.)

The characteristic pH of a saturated solution of trichlor is 2.9, an extremely low and aggressive value! On the other hand, the apparent chlorine content is high, calculated at about 90% - hence an easy sale to performance seekers. Performance, however, diminishes as CYA accumulates...

The cost is very high, responding to a market willing to pay. In a survey of pool service companies, Service Industry News, July 14, 1995, reports that trichlor dominates the market in sales in all regions of the country except Florida and Southern California - often holding an 80% preference rating. Sadly, many indoor pool owners are among these customers.

It takes 1.12 pounds of trichlor to equate to 1 pound of gas chlorine, in terms of resultant residual. Even though there's this apparent 90% yield, the product is, by weight, over 54% cyanuric acid. A busy 120,000-gallon outdoor high-school pool using only ten pounds per day, even figuring in backwash and other water-loss dilution, could gain 4 ppm CYA per day. The pool could rise from 20 ppm CYA to a staggering, debilitating 100 ppm in only twenty days! Go figure...

The popular tri-chlor erosion feeders are often a source of severe equipment damage too, as instructions for installation have routinely included the "looping of the pump". The installer gets his "free" erosion flow from the available pressure differential across the circulation pump, thereby introducing a very low pH solution prior to the pump impeller, the filter and the heater. You've seen installations like this... at all those hotel spas with the pretty turquoise plaster! The untrained use of trichlor, even with properly installed systems injecting downstream from all a pool's equipment, often leads to equipment and plaster damage nonetheless. Uncorrected, the naturally low pH of the dissolved product erodes total alkalinity as well as the water's pH, causing the saturation index to plummet. A properly introduced alkalizer is absolutely necessary to maintain the necessary mid-seven pH in the water.

In the experience of this writer, mis-use of tri-chlor now rivals both gas chlorine and acid washes in the competition for the most common source of costly public-pool damage!

REGARDING INDOOR USE OF CYA: It must be emphasized here that the indoor-pool use of cyanuric acid or stabilized chlorine products is wholly inappropriate. CYA serves only to reduce the loss of chlorine residual due to ultraviolet radiation from the sun; there's none of that indoors, so higher priced chlorine works much less and lasts no longer. It's the hoggish (or, more typically, uninformed) contractor who installs that cheap erosion feeder on a new indoor pool when the designer fails to specify a more appropriate sanitizer and feed system. That forces the owner to use the only type of chlorine that works in such a feeder - expensive, potentially damaging, less-effective trichlor. So as you're wasting your money you may be harming your plaster or destroying the metal pump, filter and heater too!

Those who knowingly sell CYA or stabilized chlorine for use in indoor pools or spas do so out of ignorance or greed. There can be no other reason.

TOTAL DISSOLVED SOLIDS - THE COVER STORY: Total dissolved solids (TDS) naturally elevates as the CYA and the sodium chloride build. As the stabilizer accumulation becomes excessive, TDS is often blamed for a noticeable and sometimes severe drop-off in oxidation and disinfection. Unacceptable cloudiness, algae and even bad health-department reports can be the result, but CYA is held blameless as fingers continue to point at TDS.

"Oh my gosh, you're nearing 3000 ppm TDS; drain your pool!" is a common cry. Don't buy this one. As reported in PrP #1 (What's All This Fuss Over TDS), high TDS has been inappropriately maligned for as long as CYA's been around. 10,000 ppm and much more can be harmless in public pool water, as the predominant constituent of TDS in all "aged" pool water is common, everyday salt. In non-stabilized pools, lofty TDS allows perfectly satisfactory chlorine effectiveness. Even chlorine in sea-water pools, at 33,000 ppm TDS, works just fine! Published statements that even 50% reduction in chlorine's effectiveness occurs when TDS rises to "2000 ppm or 1000 ppm above the make-up water" are patently false.

"No, it's not TDS, it's the 200 ppm CYA..." might be the more accurate observation when cloudy water and algae appears. Drain, dilute, or otherwise reduce the CYA so some ORP emerges and chlorine can go back to work. Don't blame TDS!

LOW LEVELS OF CYA DO WORK AFTER ALL: "Little if any stabilization is available at levels of CYA less than 30 ppm" is a commonly heard admonishment. Some sanitarians require this or similar minimums. Actually, the stabilization curve declines smoothly, not abruptly (see Part I) and it is reasonable to expect some retention at very low values of the product.

A major Western university used CYA for a season, then experienced an interesting phenomenon. The operator loaded the pool to the "recommended" level of 50 to 60 ppm. He was not pleased with the result, as water cloudiness occurred any time the pool was heavily used (high organic introduction/low oxidation) and clarity was restored only after a lightuse day or two. At the end of the season, he drained the pool completely, refilled and re-balanced. He learned that, while dilution with unstabilized water is the normal method of reducing CYA levels, total elimination of the stabilizer is quite difficult. Even a thorough draining won't eliminate all of it, as puddling and absorption in filter media, pipes, plaster and elsewhere retains small amounts. Such was the case at the university's pool.

During the season following the draining, surprising economies were noted, with chemical costs a bit more than the stabilized season but considerably better than two years earlier with no CYA. The water was analyzed, revealing less than 2 ppm CYA! It seems that, since cyanurics couldn't be removed entirely, the trace value was enough to effect a significant degree just what the operator was looking for!

SALES MOTIVATION: Alluded to throughout this paper, sales more than chemistry is often the science behind the promotion and use of cyanuric acid. Among the highest-profit items on the pool-supply guy's shelf, motivation to move product is obvious. CYA offers an unprecedented opportunity for irresponsible promotion and training, thus counterproductive mis-application. Responsible sales folks ask if a customer's pool is outdoors, what the organic load is expected to be, how much stabilizer is already in the water. Responsible trainers explain all the consequences as well as the advantages of CYA.

Those pool operators and owners who choose to stabilize their chlorine bite off a new responsibility, that of testing and maintaining the CYA at reasonable and consistent levels. Especially when electronic automation is used, where calibration of the unit is based on the artificial offset created by the level of the product, variations in CYA cause unacceptable errors in accuracy and control.

While the controller's consistency and calibration is dependent on a steady level of CYA, the readability of the already inaccurate testing methods is particularly poor at the low levels suggested here. Dosing and replenishing by calculation, measurement of make-up water and estimation of evaporation has worked best to achieve a constant value of stabilization.

SUMMARY COMMENTS: How about reducing cyanuric acid, since it is considered "permanent" in pool waterĐMelamine, the precipitant-forming reagent used in the test kits, can be purchased in large quantities, administered to the pool, left undisturbed with the pumps off for a couple of days... then the white residual can be vacuumed off the bottom. The impossible has been done; most of the CYA has been removed from the water. This is costly in chemicals and downtime, of course. The better way is to monitor, manage and limit your pool's stabilizer in the first place.

Upper limits are regulated in most states, usually to 100 ppm cyanuric acid. This limit is for toxicity reasons, however, not an endorsement of its use to that level. Neither is a value above the 100 ppm figure reason for serious health concerns, as levels in the thousands have not proven toxic in some studies. But, as one health official said, "If a higher concentration can't possibly do any more good, why take any chance that it might do harmĐ"

This writer has, by the way, used cyanuric acid successfully and with benefit in his own pool for years. Trash or treasure, curse or blessing, yin or yang, it's all in the context of consequence! We just hope, if you're using CYA, it is appropriate for you and it works for you. Frankly, for many operators, it's not and it doesn't. ~ KW

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