Pool Standards, 2006

for the Swimming Pool, Wading Pool and Water Spray Park Regulation

Alberta

Pool Standards, 2006
for the
Swimming Pool, Wading Pool and Water Spray Park Regulation

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.

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.

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 40^0 C (104^0 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.

I. 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).

II. 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**.**

III. 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:

A. 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.

B. 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.

IV. 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.

V. 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.

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/cm^2. 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/cm^2 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*

Dr. Norman Neumann, Provincial Laboratory for Public Health
Dr. Steve Craik, Assistant Professor, Department of Civil and Environmental Engineering, University of Alberta
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 setting, the paper by Gyűrek, L.L., Finch, G.R. and Belosevic, M. (1997) provides the following information of extrapolated results from their predictive inactivation model:

pH	Tempº C	Ct 2 log inactivation	Ct 3 log inactivation
6	22	5,500	12,300
7	22	6,800	15,100
7.5	22	9,800	22,000
8.0	22	19,000	43,300

Further experimental work indicates that for *Cryptosporidium*, a Ct of 9600 may provide 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*

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

- 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.

Bibliography

Alberta Association of Recreation Facility Personnel. (1998) *Guidelines for the Operation of Public Aquatic Facilities.*

Alberta Association of Recreational Facility Personnel. *Recommended Procedure for Fecal Accidents in a Swimming Pool.*

Attye.A. et al.(1990) "Incidence of Occult Athletes Foot in Swimmers". European Journal of Epidemiology. 6(3):244-247.

Calgary Health Region. (March 2002) *Field Operations Procedures Relating to Swimming Pool and Whirlpools.*

Capital Regional Health Authority. (November 2001) *"Management of Fecal Accidents in Swimming Pools".*

Carpenter, C. et al. (1999) "Chlorine Disinfection of Recreational Water *Cryptosporidium parvum*". Emerging Infectious Diseases, 5(4): 579-584.

Croll, BT. (2002) "The latest position in *Cryptosporidium* control". Presented at the School of Water Sciences conference on Swimming Pool Water Quality and Treatment. (personal email)

Government of British Columbia. *Swimming Pool, Spray Pool and Wading Pool Regulations*. British Columbia Regulation 289/72.

Government of Manitoba. *Swimming Pools and Other Water Recreational Facilities Regulation*. Manitoba Regulation 132/97.

Government of Ontario. *Health Protection and Prevention Act. Public Pools Regulation* 1990 amended to 179/02.

Government of Saskatchewan. *Public Health Act 1994. The Swimming Pool Regulations,* 1999. Chapter P-37.1 Reg 7.

Gregory,R. (2002) "Benchmarking Pool Water Treatment for Coping with *Cryptosporidium*". Journal of Environmental Health Research, 1(1): 11-18.

Gyűrek, L.L., Finch, G.R., Belosevic, M. (1997) "Modeling Chlorine Inactivation Requirements of *Cryptosporidium parvum* Oocysts". Journal of Environmental Engineering. 123(9):865-875.

Hannuksela, M. L., Ellahham, S. (2001) “Benefits and Risks of Sauna Bathing”. American Journal of Medicine. 110(2):118-26.

Kamihama,T. et al. (1997) "*Tinea pedis* outbreak in swimming pools in Japan". Public Health. 111(4):249-253.

Kauppinen,K.(1997) “Facts and fables about sauna”. Annals of New York Academy of Sciences. 813:654-63.

Kebabjian, Richard. (1995) "Disinfection of Public Pools and Management of Fecal Accidents". Journal of Environmental Health, 58(1): 8-12.

Lifesaving Society. (2001) *Public Aquatic Facility Safety Standards*.

Lifesaving Society. (2002) *Wading Pool Guidelines*.

Lifesaving Society. (1999) *Waterfront Safety Standards*.

Minnesota Department of Health. (September 2002) *"Recommended Guide for the Removal of Fecal Matter from a Swimming Pool for Consideration by Pool Owners and Operators".*

New South Wales Health Department. (December 1999) "Protocol for Minimising the Risk of *Cryptosporidium* Contamination in Public Swimming Pools and Spa Pools".

Pool Water Treatment Advisory Group. (PWTAG*) (*1999) *Swimming Pool Water Treatment and Quality Standards.* England.

New South Wales Health Department. (June 1996) *Public Swimming Pool and Spa Pool Guidelines*.

Steinenger, Jacques.(1991):”Improving Pool Sanitation” Journal of Environmental Health. May/June 53(6): 26-28.

United States Centre for Disease Control. (May 25, 2001) "Notice to Readers: Responding to Fecal Accidents in Disinfected Swimming Venues". Morbidity Mortality Weekly Report, 50(20):416-417

United States Consumer Product Safety Commission. (March 2005) *Guidelines for Entrapment Hazards: Making Pools and Spas Safer*

World Health Organization. (August 2000) *Draft Guidelines for Safe Recreational - Water Environments*.

Williams, Kent. (1997) "Cyanurics - Benefactor or Bomb". Professional Pool Owners of America.

World Health Organization. (2006) *Guidelines for safe recreational water environments. Volume 2: Swimming pools and similar environments.*