ACT DEPARTMENT OF HEALTH AND COMMUNITY CARE

PUBLIC HEALTH RISKS FROM SWIMMING/SPA POOLS

PART B:
INFORMATION ON THE CONTROL OF CRYPTOSPORIDIUM AND GIARDIA

CONTENTS

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INFORMATON ON PUBLIC HEALTH RISKS FROM SWIMMING/SPA POOLS CONTROL OF CRYPTOSPORIDIUM AND GIARDIA

1. INTRODUCTION

Cryptosporidium and *Giardia* can be found in surface waters *(lakes, rivers)* and treated waters *(drinking water, swimming pool water)* contaminated by animal and human faeces. Mode of transmission of the diseases can be faecal-oral including person to person, animal to person, foodborne and waterborne.

Cryptosporidium is a minute protozoan parasite of about four to seven micrometres in diameter. It is very resistant to common disinfectants. The parasite infects the intestine and ingestion of as few as one to ten *Cryptosporidium* oocysts may result in infection. An infected person often displays no symptoms but in those who become ill the symptoms may include diarrhoea, vomiting, stomach pains, loss of appetite and low grade fever. The incubation period is between one and twelve days with an average of seven days. The duration of illness in otherwise healthy people is less than two weeks but may last four to six weeks. The disease (cryptosporidiosis*)* may be severe and prolonged in immuno-compromised people. There is no specific treatment for cryptosporidiosis.

Giardia is a minute protozoan parasite of about eight to twelve micrometres in diameter. It is resistant to common disinfectants though not to the same extent as *Cryptosporidium*. Like *Cryptosporidium*, the parasite infects the intestine and ingestion of as few as one to ten *Giardia* cysts may result in infection. An infected person often displays no symptoms, but in those who become ill the symptoms may include diarrhoea, stomach pain, fatigue and weight loss. The incubation period is between three and 25 days with an average of seven to ten days. Specific drug treatment is available for the disease (giardiasis*).*

Cryptosporidiosis and Gardiasis are notifiable diseases in the ACT. Medical practitioners, hospitals and pathology laboratories are required to notify the Chief Health Officer of cases.

2. SCOPE

This document sets out information concerning the procedures recommended for a multi-barrier risk management approach for the control of *Cryptosporidium* and *Giardia* in swimming pools, leisure pools, spas and hydrotherapy pools in the ACT whether they be commercial, private or public. It provides the **additional** control measures to be initiated over and above those provided for in existing guidelines for the management of pools.

There are many existing guidelines for the management of pools and spas including:

- Standards Australia AS 3633 - 1989 Private Swimming Pools Water Quality.
- National Environmental Health Forum Guidance on Water Quality for Heated Spas Water Series No 2 1996.
- Various state publications e.g. New South Wales Health Department Public Swimming Pool and Spa Pool Guidelines 1996.

3. DISINFECTION

In addition to disinfection measures recommended in existing guidelines, operators should implement one or more of the following options for ongoing *Cryptosporidium* and *Giardia* control in pool water.

The microscopic size of *Cryptosporidium* and *Giardia* means that common sand and cartridge filters are not totally effective in removing these parasites. They are also resistant to usual pool water disinfectants *(e.g. chlorine, bromine)* at normal operating levels. These characteristics present problems for pool operators in

attempting to prevent the spread of disease in the event of the pool becoming contaminated. The following options are available for ongoing *Cryptosporidium* and *Giardia* control in pools:

1. full stream ozone
2. side stream ozone
3. shock dose chlorine dioxide
4. full stream micro-filtration
5. side stream micro-filtration
6. side stream diatomaceous earth filtration
7. ongoing chlorine dosing
8. shock dose chlorine.

Only stabilised chlorine dioxide *(liquid)* is recommended for use in this code of practice.

These options can be categorised by the treatment classification system displayed below in **Table 1**.

Table 1: Treatment Classification System

Method	Approach				Disinfection Treatment		Disinfection Type	
	Full Stream	Side Stream	On-going Residual	Shock Dose	Chemical	Physical	Inactivation	Removal
1	✓				✓		✓	
2		✓			✓		✓	
3				✓	✓		✓	
4	✓					✓		✓
5		✓				✓		✓
6		✓				✓		✓
7			✓		✓		✓	
8				✓	✓		✓	

Clarification of the terminology used in the treatment classification system is detailed below:

3.1 Approach

3.1.1 Full Stream

This approach allows treatment by the disinfection method on the entire flow of water in the filtration cycle. This in theory allows disinfection of all water in the pool in one complete water turnover period. However, in practice it may take up to four full water turnover periods in a functioning, well designed pool with excellent circulation and mixing characteristics to achieve 99.5% treatment of the water.

3.1.2 Side Stream

The side stream approach is an alternative to full stream. By treating a smaller percentage of the water flow, this approach hopes to provide acceptable levels of risk management while reducing costs to a level which may be commercially viable for a wider range of pool complexes.

By way of explanation of the side stream concept, if the existing chlorine and filtration system treats all pool water every four hours *(water turnover period)* and the side stream system is designed at 20% of main system capacity, then theoretically every 20 hours all water would be treated by the disinfection method. Again it should be noted that in practice it may take up to four turnover periods to achieve effective treatment of the water with full stream systems. This would require up to 20 water turnover periods for a 20% side stream system.

3.1.3 Ongoing Residual

A method of inactivation in which a constant residual of disinfectant is maintained in the pool water at all times.

3.1.4 Shock Dose

This approach does not offer an on-going treatment but relies on regular shock dosing of the pool water by a disinfection treatment. The theoretical time period for disinfection is therefore not related to the water turnover period of the pool, but to the interval between effective shock dosing *(i.e. daily, weekly, monthly etc.).*

3.2 Disinfection Treatment

3.2.1 Chemical

This category includes all liquids, gases and solids which are added to the pool water to cause a chemical reaction which results in disinfection of the water by inactivation of *Cryptosporidium* oocysts and *Giardia* cysts.

3.2.2 Physical

Any method which relies on physical removal or entrapment of the *Cryptosporidium* oocysts and *Giardia* cysts.

3.3 Disinfection Type

Inactivation

The result of a disinfection treatment which inactivates the *Cryptosporidium* oocysts and *Giardia* cysts causing them to become non-viable.

Removal

The result of a filtration treatment which physically removes *Cryptosporidium* oocysts and *Giardia* cysts from the pool water.

The following section discusses treatment options including effectiveness and cost. It is suggested that pool operators seek advice from industry as to specific costs for individual needs.

3.3.1 Full Stream Ozonation

Research undertaken into proven methods of disinfection for *Cryptosporidium* and *Giardia* consistently identifies ozonation as the most effective treatment. This literature suggests a contact time *(C.t)* value *(multiplication of the disinfection concentration in mg/L and the time in minutes required to inactivate a particular parasite)* for ozone of between five and ten. This results in inactivation of >99% in normal swimming pool temperatures and pH levels. If sufficient concentrations and contact time are assured, then this process should theoretically provide >99% inactivation of *Cryptosporidium* and *Giardia* in one water turnover period. Again it should be noted that in practice it may require up to four turnover periods to provide effective treatment of all of the water.

3.3.2 Side Stream Ozonation

The literature suggests a C.t value of between five and ten for *Cryptosporidium* and *Giardia*. This results in inactivation of > 99% in normal swimming pool temperatures and pH levels. The side stream approach only treats a specified percentage of the water each water turnover period and is therefore less effective than full stream ozone. The theoretical time period for inactivation is related to the water turnover period, pool design, actual circulation pattern and is dependent on the percentage of the main stream flow which is being treated. In practice, effective treatment of the water may not be achieved in less than four turnover periods in a full stream system. A side stream system needs to be adjusted proportionately. A range of 25-40% of full flow is suggested.

3.3.3 Shock Dose Chlorine Dioxide

Research has identified chlorine dioxide as an effective *Cryptosporidium* and *Giardia* disinfectant agent. This research suggests a C.t value of 78 and results in inactivation of >90% for both parasites at normal swimming pool temperatures and pH levels.

The effectiveness of the shock dosing method as a *Cryptosporidium* and *Giardia* control option is not only reliant on the concentration and contact time of the dosing, but on the regularity of these doses. This shock dosing method should be carried out overnight due to degradation by sunlight and is recommended on a weekly basis during peak season for commercial operations. A 0.25 mg/L concentrated dose for six hours is suggested for this option.

3.3.4 Full Stream Micro-Filtration

Literature suggests that an *'absolute one micron rated filter'* will remove *Cryptosporidium* oocysts and *Giardia* cysts.

3.3.5 Side Stream Micro-Filtration

The literature suggests that an *'absolute one micron rated filter'* will remove *Cryptosporidium* oocysts and *Giardia* cysts. However, the side stream micro-filtration approach requires a greater number of water turnovers to achieve the same result as full stream micro-filtration.

3.3.6 Side Stream Diatomaceous Earth Filtration

Diatomaceous earth filtration has the capacity to remove particles of three to five microns in size and whilst not guaranteeing 100% removal of *Cryptosporidium* oocysts, does provide another barrier in the control of *Cryptosporidium* and *Giardia*.

3.3.7 On-Going Chlorine Dosing

On-going chlorine dosing of pools is not necessarily an additional method of control as this may be part of best practice pool management. However, an increase in the average level of free chlorine should result in some measure of control over *Cryptosporidium* and more particularly *Giardia* which is more susceptible to disinfectants.

Research on the effectiveness of chlorine as an effective *Cryptosporidium* and *Giardia* disinfection solution conflicts. A C.t value of 7,200 for 90% inactivation has been adopted based on the consensus of the literature reviewed. Increasing the average level of free chlorine above that recommended for normal pool operation (e.g. 2 mg/L to 4 mg/L) should result in a reduction in the inactivation time period, but this should not be assumed to be a direct linear increase.

3.3.8 Shock Dose Chlorine

It has been assumed for the purposes of this Code of Practice that chlorine has a C.t value of 7,200 for 90% *Cryptosporidium* and *Giardia* inactivation at normal pool water temperatures and pH. Using this value, concentrations and contact time can be measured for shock dosing at regular intervals.

Similar to chlorine dioxide shock dosing, the effectiveness of this option is reliant on the concentration and contact time of the dosing as well as the regularity of these doses. Shock dosing should be carried out overnight on a weekly basis during peak season for commercial operations.

A 40 mg/L concentrated dose for three hours is suggested for this option.

Following shock dosing, the water should be dechlorinated using sodium thiosulphate and the water chemistry balanced.

For commercial operators where pool water is not discarded annually, consideration should be given to the form of chlorine used for shock dosing. Advice should be sought from industry.

4. POOL SAMPLING AND REMEDIATION PROCESSES

Pool water becomes contaminated with *Cryptosporidium* or *Giardia* when an infected person excretes the oocysts or cysts into the water. Sampling of the water for *Cryptosporidium* and *Giardia* will only provide a result for the actual volume of water sampled at a point in time and will not ensure ongoing safety from infection.

A regular program of sampling for *Cryptosporidium* and *Giardia* is **not** recommended as proper attention to pool design, maintenance and operation are the most effective measures to control the risks of disease. However, it is recognised that some pool operators may choose to carry out sampling on their own initiative at any time.

Where evidence suggests a particular pool may be associated with cases of disease, the ACT Department of Health and Community Care will undertake an investigation including sampling of the pool. Where *Cryptosporidium* oocysts or *Giardia* cysts in samples are obtained from a pool, the ACT Department of Health and Community Care may recommend the pool's closure.

Where a pool operator chooses not to act on this recommendation, the ACT Department of Health and community Care may invoke legislative powers under the *Public Health Act 1997* to minimise risk to public health.

Pool remediation will be required to be conducted.

The re-opening of pools closed voluntarily by the pool operator or by the ACT Department of Health and Community Care will be based on a nil viable oocyst or cyst presence in the water. If viability testing is not available, re-opening will be based on no oocysts or cysts being detected.

Where pools have tested positive, the following methods of pool remediation have been proven to be successful:

4.1 Disinfection by shock dosing with chlorine

1. close the pool
2. backwash filters
3. flocculate filters with alum
4. raise the chlorine level to 90 mg/L and operate the plant in filtration mode for one water turnover period
5. ensure all pool elements are activated and therefore treated
6. steam clean all amenities in contact with the pool water
7. backwash filters
8. flocculate filters with alum
9. reduce the chlorine level if necessary to normal operating range using sodium thiosulphate
10. balance water chemistry.
11. sample the pool water for *Cryptosporidium* and *Giardia*
12. a negative test result is required for re-opening

4.2 Disinfection by shock dosing with chlorine dioxide

1. close the pool
2. backwash filters
3. flocculate filters with alum
4. operate the plant in filtration mode for one water turnover period
5. repeat steps 2 and 3
6. steam clean all amenities in contact with the pool water
7. chemical dose pool water with chlorine dioxide at 2.6 mg/L
8. circulate water for one turnover period
9. ensure all pool elements are activated and therefore treated
10. backwash filters
11. balance water chemistry
12. sample the pool water for *Cryptosporidium* and *Giardia*
13. a negative test result is required for re-opening.

NB This method has proved successful. However further research indicates that a lesser concentration of chlorine dioxide viz 1.25 mg/L for two hours or one water turnover period is equally effective.

4.3 Physical removal of pool water

1. empty the pool water to a sanitary sewer or storm water drain following consultation with Environment ACT.

2. thoroughly scrub down the pool surfaces with a commercial detergent/disinfectant
3. drain and steam clean all pipes, pumps, fittings etc.
4. steam clean all amenities in contact with the pool water
5. change the filter medium
6. refill the pool and return chlorine levels to the normal operating range
7. balance water chemistry
8. sample the pool water for *Cryptosporidium* and *Giardia*
9. two negative test results are required for re-opening

The full completion of any one of the above processes should provide a satisfactory remediation of the pool. The choice of process is dependent upon the size and nature of the pool complex, and available funds and costs.

5. METHODS FOR THE DETECTION AND ISOLATION OF CRYPTOSPORIDIUM AND GIARDIA IN WATER

Most currently available methods for the detection of *Cryptosporidium* and *Giardia* do not have the ability to detect different species, nor do they have the ability to differentiate between viable and non-viable organisms.

The acceptability of the method used in any private sampling process will be decided by the ACT Department of Health and Community Care when assessing sample results.

Where viability testing is not available, a nil presence of *Cryptosporidium* oocysts or *Giardia* cysts is required to allow re-opening of a pool previously found to be positive. Where viability testing is carried out, a nil presence of viable organisms is required to allow re-opening.