

S O U T H A U S T R A L I A N H E A L T H C O M M I S S I O N C O D E

S T A N D A R D

F O R T H E

Operation of Swimming Pools and Spa Pools in South Australia

SUPPLEMENT C

BROMINE DISINFECTION
of swimming pool, spa pool,
hydrotherapy pool
& waterslide pool water

DEPARTMENT OF HUMAN SERVICES

(SOUTH AUSTRALIAN HEALTH COMMISSION)



**Government
of South Australia**

May 1992

SUPPLEMENT C ~ Bromine disinfection of
swimming pool, spa pool, hydrotherapy pool
& waterslide pool water

Prepared by:

Environmental Surveillance Section,
Environmental Health Branch
Department of Human Services
South Australian Government

This guideline is one of a series of guidelines to assist
Local Government in the administration of the Public
and Environmental Health Act and Regulations.

Should you wish to comment on the information
in this guideline, your written comments are welcome
and should be addressed to:

Presiding Member,
Public & Environmental Health Council
PO Box 6, Rundle Mall, Adelaide 5000

ISBN 0-7308-2249-4

FOREWORD

Under the Public and Environmental Health Act, Section 47(5) provides that a regulation under the Act may incorporate or operate by reference to any code or standard prepared or approved by a body or authority referred to in the regulation.

Public and Environmental Health Regulations 6(1)(a) and 7(1)(a) provide that swimming pool or spa pool waters, when available for public use, must be disinfected by a method specified by the South Australian Health Commission Code “Standard for the Operation of Swimming Pools and Spa Pools in South Australia”.

To assist local councils in the administration of the Public and Environmental Health Act and Regulations the Public and Environmental Health Council has requested that a supplement to the South Australian Health Commission Code “Standard for the Operation of Swimming Pools and Spa Pools in South Australia” be produced and address the use of bromine as a pool water disinfectant for swimming pools (including hydrotherapy pools and waterslides) and spa pools.

This supplement has been prepared to address the operation and disinfection of swimming pools (including hydrotherapy pools and waterslides) and spa pools with bromine and provide details on measures necessary to ensure that water quality within pools is of a standard that does not prejudice the health or well-being of the pool users.

It describes the disinfection of pool water with the various forms of bromine and refers to those important parameters such as pH, water clarity, pool water turnover rate and total alkalinity that need to be maintained in balance as part of the total water treatment process.

This supplement is aimed primarily for use by local government agencies responsible for the administration of the Public and Environmental Health Act and Regulations. It will also be useful for the operators of swimming pool and spa pool facilities.

Public and Environmental Health Regulation 3 details the facilities to which the provisions of this supplement apply, defines a “spa pool” and a “swimming pool” and establishes when such pools are taken to be “available for public use”.

This supplement, to the Code “Standard for the Operation of Swimming Pools and Spa Pools in South Australia” as provided for under Section 47(5) of the Public and Environmental Health Act and Regulations 6(1)(a) and 7(1)(a), is a prescribed code. Non compliance with the provisions applicable to the disinfection process including the maintenance of pool water quality so that it is chemically balanced is deemed to be a breach of the legislation and subject to penalty as indicated in Regulations 6(3) and 7(3). The pool water turnover rates for hydrotherapy pools and waterslides are recommendations only until incorporated into the regulations.

CONTENTS

FOREWORD	3
INTRODUCTION	5
DEFINITIONS	6
MANAGEMENT	8
BROMINE AS A DISINFECTING AGENT	8
<i>Two methods for producing hypobromous acid</i>	8
Method 1	8
Method 2	9
<i>Bromamine formation</i>	9
DISINFECTION & TREATMENT	10
<i>Swimming pools</i>	10
<i>Spa pools</i>	11
<i>Hydrotherapy pools</i>	11
<i>Waterslides</i>	11
TABLES	12
ACKNOWLEDGMENTS	14
REFERENCES	14

INTRODUCTION

This supplement applies to swimming pools and spa pools as defined by the Public and Environmental Health Regulations and where the pool water is disinfected with bromine.

Bromine has been used as a swimming pool and spa pool water disinfectant throughout the world for a number of years. Under previous South Australian health legislation spa pools were not covered and bromine could be used as a disinfecting agent in spa pools without approval. As bromine had not been approved for use in South Australia it was not included in the provisions of the Public and Environmental Health Regulations.

To redress this anomaly industry representatives sought approval of bromine as a disinfectant for swimming and spa pool waters. Following a review of the technical data and conducting field trials in several pools to determine the efficacy of bromine against a range of organisms approval was subsequently granted.

Use of bromine as a pool water disinfectant tends to produce less odour problems than in poorly maintained chlorine treated pools. Its efficacy is similar to that of chlorine and it is effective over a wider pH range than chlorine. Both bromine and chlorine are destroyed by sunlight, but unlike chlorine, bromine cannot be stabilized against the destructive effects of ultraviolet light.

A number of different methods and bromine producing compounds may be used to disinfect pool water and whilst the processes differ they are all suitable and achieve the same effect as other approved chemical disinfectants.

One common method of producing bromine in pool water involves the addition to the water of sodium or potassium bromide in conjunction with an oxidizer such as sodium hypochlorite or monopotassium persulphate. These substances are available as solutions and they are readily dosed into pool water.

Another common method of producing bromine in pool water is to add 1-bromo-3-chloro-5, 5-dimethylhydantoin (BCDMH) to the water. BCDMH is available in tablet or granule form and since it is more acidic (pH of 4.5) than some other disinfectants it will reduce the total alkalinity of pool water more rapidly than other disinfectants. To compensate for this factor it is necessary to ensure that the total alkalinity levels in the pool water are maintained within the range of 150 mg/L to 200 mg/L.

Continuous dosing of bromine can readily be achieved, but depending on the bromine producing chemical used, the amount of disinfecting agent available to satisfy the immediate bather load may vary. Therefore, care should be taken to ensure that the necessary levels of bromine disinfectant are maintained whilst the pool is in use.

As with other chemical disinfectants it is sometimes necessary to shock dose the pool water to destroy accumulated organic matter that cannot be reduced through partial replacement of the water. Should it be necessary to shock dose the pool water it should only be done when there are no bathers in the pool.

This supplement should be read in conjunction with the relevant parts of the following:-

- SAHC Code “Standard For The Operation of Swimming Pools and Spa Pools in South Australia”
- SAHC Code “Standard For The Operation of Swimming Pools and Spa Pools in South Australia, Supplement `A' Waterslides”
- SAHC Code “Standard For The Operation of Swimming Pools and Spa Pools in South Australia, Supplement `B' Hydrotherapy Pools”
- SAHC Code of Practice “Standard For The Inspection and Maintenance of Swimming Pools and Spa Pools in South Australia”

All legislation, codes, codes of practice, standards, or guidelines referred to in this supplement include amendments made from time to time unless otherwise stated. The provisions of this supplement do not derogate from the need to comply with other laws of the State.

DEFINITIONS

<i>automatic analysis equipment</i>	equipment that continuously analyses and controls disinfectant and pH levels in pool water.
<i>BCDMH</i>	1-bromo-3-chloro-5, 5-dimethylhydantoin.
<i>bather load</i>	the number of persons in the pool at any given period of time.
<i>bromine</i>	hypobromous acid/hypobromite ion (irrespective of the mode of addition or formation).
<i>chlorine</i>	hypochlorous acid/hypochlorite ion (irrespective of the mode of addition or formation).
<i>combined bromine</i>	bromine that has combined with ammonia, ammonium compounds or organic matter containing nitrogen to form bromamines.
<i>disinfecting agent</i>	a compound or substance which, when applied as instructed to swimming or spa pool water, kills harmful micro-organisms.
<i>flume</i>	an artificial channel or trough which conducts water and is used to transport persons from a raised platform to a receiving waterslide pool.
<i>free bromine</i>	bromine that has not combined, but is free to kill bacteria and algae and destroy organic pollutants introduced into the pool water.
<i>hydrotherapy</i>	external application of, or partial immersion in water for the treatment of illness or injury or for fitness exercising.
<i>hydrotherapy pool</i>	a pool containing heated water and specially designed to meet the therapeutic needs of persons of any age with impairments due to illness, injury, disease, intellectual handicap or congenital defects or for fitness exercising.
<i>knowledgeable person</i>	one who is able to control, manage and operate a pool to ensure that the pool water complies with the requirements of the Public and Environmental Health Regulations.
<i>mg/L</i>	milligram per litre.
<i>occupier</i>	in relation to premises, means a person who has, or is entitled to, possession or control of the premises and includes a person who is in charge of the premises.
<i>operator</i>	the person who has control and management of the pool, is knowledgeable in its operation and is sufficiently competent to ensure that the pool complies with the requirements of the regulations.
<i>owner</i>	in relation to premises, includes an occupier of the premises.
<i>pH</i>	a scale ranging from 0 to 14 that indicates the amount of acid or alkali present in the water. Water with a pH of 7 is neutral.
<i>SAHC</i>	South Australian Health Commission.
<i>shock dose</i>	the addition to pool water of at least 10 mg/L of chlorine or 20mg/L of bromine for the destruction of combined chlorine or combined bromine, algae, and other impurities.
<i>skimmer gutter</i>	a drainage system provided to collect surface water flow from the pool and return it to the treatment plant or to waste.
<i>skimmer weir</i>	a device provided to ensure that pool water is drawn from the surface for return to the treatment plant or to waste.
<i>spa pool</i>	means a pool or other water-retaining structure designed for human use: (a) that is capable of holding more than 680 litres of water; <i>and</i> (b) that incorporates or is connected to, equipment that is capable of heating any water contained in it and injecting air bubbles or water into it under pressure so as to cause general turbulence in the water.
<i>superbromination</i>	the addition of sufficient bromine to pool water to raise the level of free bromine to at least 20 mg/L for the destruction of combined bromine (bromamines), algae, and other impurities.

<i>superchlorination</i>	the addition of sufficient chlorine to pool water to raise the level of free chlorine to at least 10 mg/L for the destruction of combined chlorine (chloramines), algae, and other impurities.
<i>swimming pool</i>	includes any waterslide, wave pool, hydrotherapy pool or other similar structure designed for human use other than: (a) a spa pool; <i>or</i> (b) a tidal pool or other similar structure where water flows in and out according to the operation of natural forces.
<i>total alkalinity</i>	a measure of the total amount of dissolved alkaline compounds in the pool water.
<i>total dissolved solids</i>	a measure of the total amount of dissolved inorganic compounds in the pool water.
<i>turbidity</i>	the degree to which suspended particles in pool water obscure visibility.
<i>turnover rate</i>	the period of time required to achieve complete exchange of the pool water through the filter.
<i>waterslide</i>	consists of a specially designed flume on a supporting structure with a receiving splash pool at the base of the flume.
<i>waterslide pool</i>	an artificial body of water used to receive persons discharged from a waterslide flume.

MANAGEMENT

Where a swimming pool or a spa pool is available for use by the public the owner of the facility must ensure that the pool is under the control and management of a person who is knowledgeable and competent in the operation of the plant and maintenance of pool water quality. Whilst the facility is available for use by the public it is the responsibility of the owner and the pool operator to ensure pool water quality is maintained in accordance with the requirements of the Public and Environmental Health Regulations.

For the purpose of Public and Environmental Health Regulation 8(1)(a), possession of a qualification approved by the South Australian Health Commission may constitute prima facie evidence of the knowledge and competence required of the person in charge of a swimming pool or spa pool. The knowledge and competence of the operator may also be assessed by the standard of the water quality within the swimming pool or spa pool, as indicated below.

Owners of pools covered by the ambit of the regulations are responsible for ensuring the pool is correctly operated. Failure to do so could result in legal proceedings being implemented for non compliance.

Where the operator of a pool fails to maintain pool water quality in the manner prescribed the authority may deem the operator not to be competent and require the owner to provide a person who is competent.

BROMINE AS A DISINFECTING AGENT

As a disinfecting agent and oxidant, bromine remains active at higher pH levels than chlorine. It is, however, destroyed by sunlight and there are no stabilizers available which will significantly prevent this destruction.

In the presence of ammonia, bromine will rapidly form relatively unstable ammonia bromamines which possess disinfection efficiencies comparable to that of free bromine. It is unnecessary to destroy ammonia bromamines via breakpoint bromination because they do not produce irritating odours, they have a relative lack of stability and their disinfection efficiency approximates that of free bromine. Therefore, superbromination of pool water may not be necessary.

However, for bromine-chlorine disinfection systems, superchlorination of the pool water may be required in order to destroy any chloramines that may form. Superchlorination will also convert bromide ions present in the pool water to active bromine and therefore increase the level of free bromine.

Partial replacement of the water in swimming pools should be undertaken on a regular basis. This is done to prevent the accumulation of dissolved solids and organic matter in the pool water to levels which may interfere with the disinfection process and/or have an adverse health effect on bathers.

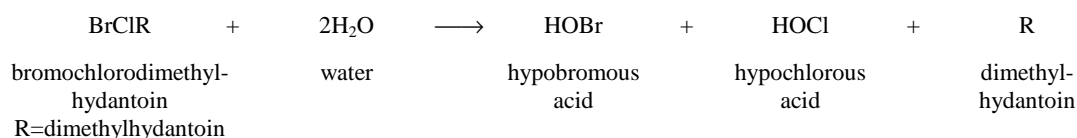
All of the bromine disinfecting agents form hypobromous acid which then acts as the pool water disinfectant. Therefore, all of the agents disinfect the pool water in the same manner.

Two methods for producing hypobromous acid

Method 1

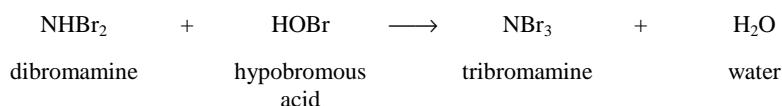
The addition of 1-bromo-3-chloro-5, 5-dimethylhydantoin (BCDMH) to pool water. It may be obtained commercially in tablet or granule form and it is sometimes expressed as bromochlorodimethylhydantoin.

The following chemical equations illustrate the reactions which take place when BCDMH is dissolved in water.



Hypobromous acid partly dissociates to give hydrogen ions and hypobromite ions.





The bromamines produced by the reaction of ammonia with hypobromous acid are effective disinfectants and they assist hypobromous acid in disinfecting pool water. They do not cause eye irritation nor do they have a strong unpleasant odour.

The bromamines formed as a result of hypobromous acid reacting with organic amines derived from bathers may have poor disinfection capabilities. They also have greater stability than the ammonia bromamines and their accumulation in pool water may hinder the disinfection of the water. The concentration of these compounds in the water can be reduced by replacing a portion of the water. The quantity and frequency of water replacement will depend on the operating conditions of the pool. However, for spa pools, water replacement must be carried out in accordance with the Regulations.

FIGURE 1: Percentage of free bromine relative to pH

<i>pH</i>	<i>Percentage of free bromine as</i>	
	<i>HOBr</i>	<i>OBr⁻</i>
6.0	100	0
7.0	98	2
7.2*	96	4
7.5*	94	6
7.6*	91	9
7.8*	87	13
8.0	83	17

* Required operating range.

DISINFECTION & TREATMENT

Swimming pools

The following conditions must be achieved whenever a swimming pool (excluding hydrotherapy pools, wave pools and waterslides) is available for use:

- the swimming pool water when disinfected with bromine must be maintained in accordance with the temperature ranges and disinfection values set out in table 1.
- the pH and total alkalinity values of the swimming pool water must be maintained in accordance with the requirements set out in table 1.
- the swimming pool must have a filtration system that provides a continuous circulation of the pool water through the filter.
- all water in the swimming pool must pass through the filter as often as necessary to ensure that the water is maintained in a clean, clear condition and in any event at least once in every six hours.
- the swimming pool must be fitted with automatic dosing and monitoring equipment that continuously analyses and controls the disinfectant and pH levels in the pool water within the range as indicated in table 1.

- pool water clarity must be maintained in a clean, clear condition so that a 150mm diameter matt black disc, or a 150mm diameter disc that contrasts with the colour of the bottom of the swimming pool, is (or would be) clearly visible when viewed through the pool water at the deepest part of the swimming pool.

Spa pools

The following conditions must be achieved whenever a spa pool is available for use:

- the spa pool water when disinfected with bromine must be maintained in accordance with the values set out in table 2.
- the pH and total alkalinity values of the spa pool water must be maintained in accordance with the requirements set out in table 2.
- the spa pool shall be fitted with a filtration system that provides a continuous circulation of water through the filter and passes all water in the spa pool through the filter at least once in every 30 minutes.
- the spa pool shall incorporate a weir off-take or skimmer system that continuously takes away surface water whilst the spa pool is in use.
- the spa pool must be fitted with automatic dosing and monitoring equipment that continuously analyses and controls the disinfectant and pH levels in the pool water within the range as indicated in table 2.
- the spa pool water clarity must be maintained in a clean, clear condition so that a 150mm diameter matt black disc, or a 150mm diameter disc that contrasts with the colour of the bottom of the pool is (or would be) clearly visible through the pool water at the deepest part of the spa pool when there is no turbulence in the spa pool water.
- the spa pool water must be replaced as required by the Regulations.

Hydrotherapy pools

The following conditions must be achieved whenever a hydrotherapy pool is available for use:

- the hydrotherapy pool water when disinfected with bromine must be maintained in accordance with the disinfection values set out in table 3.
- the pH and total alkalinity values of the hydrotherapy pool water must be maintained in accordance with the requirements set out in table 3.
- the hydrotherapy pool must have a filtration system that provides a continuous circulation of the pool water through the filter. Ideally the hydrotherapy pool should have its own filtration system. Cartridge filters and diatomaceous earth filters are not recommended.
- all water in the hydrotherapy pool must pass through the filter as often as necessary to ensure that the water is maintained in a clean, clear condition. It is recommended that this be at least once in every two hours and for heavily used hydrotherapy pools the water should pass through the filter at least once in every hour.
- the hydrotherapy pool must be fitted with automatic dosing and monitoring equipment that continuously analyses and controls the disinfectant and pH levels in the hydrotherapy pool water within the range as indicated in table 3.
- the hydrotherapy pool water clarity must be maintained in a clean, clear condition so that a 150mm diameter matt black disc, or a 150mm diameter disc that contrasts with the colour of the bottom of the hydrotherapy pool, is (or would be) clearly visible when viewed through the pool water at the deepest part of the hydrotherapy pool.

Waterslides

The following conditions must be achieved whenever a waterslide is available for use:

- the waterslide water when disinfected with bromine must be maintained in accordance with the disinfection values set out in table 4.
- the pH and total alkalinity values of the waterslide water must be maintained in accordance with the requirements set out in table 4.

- the waterslide must have a filtration system that provides a continuous circulation of the water through the filter. Ideally the waterslide should have its own filtration system.
- all water in a waterslide must pass through the filter as often as necessary to ensure that the water is maintained in a clean, clear condition. As waterslides have high bather loads it is recommended that the water should pass through the filter at least once in every hour.
- the waterslide must be fitted with automatic dosing and monitoring equipment that continuously analyses and controls the disinfectant and pH levels in the waterslide water within the range as indicated in table 4.

Waterslide water clarity must be maintained in a clean, clear condition so that a 150 mm diameter matt black disc, or a 150 mm diameter disc that contrasts with the colour of the bottom of the waterslide pool is (or would be) clearly visible when viewed at the deepest part of the waterslide pool.

TABLES

TABLE 1: Swimming pool water disinfected with bromine (excluding hydrotherapy pools, wave pools and waterslides)

<i>Pool water temperature</i>	<i>pH</i>	<i>Total alkalinity mg/L</i>	<i>Bromine mg/L</i>
	<i>Min - Max</i>	<i>Min - Max</i>	<i>Minimum</i>
< 26°C	7.2 - 7.8	60 - 200*	2.0
≥ 26°C	7.2 - 7.8	60 - 200*	4.0

TABLE 2: Spa pool water disinfected with bromine

<i>Pool water temperature</i>		<i>pH</i>	<i>Total alkalinity mg/L</i>	<i>Bromine mg/L</i>
<i>Ideal</i>	<i>Maximum</i>	<i>Min - Max</i>	<i>Min - Max</i>	<i>Minimum</i>
35 - 37°C	40°C	7.2 - 7.8	60 - 200*	8.0

NOTE for Tables 1 & 2

* It is recommended that where BCDMH is used as the pool water disinfectant the total alkalinity should be maintained in the range 150-200 mg/L.

TABLE 3: Hydrotherapy pool water disinfected with bromine

<i>Pool water temperature</i>	<i>pH</i>	<i>Total alkalinity mg/L</i>	<i>Bromine mg/L</i>
<i>Ideal</i>	<i>Min - Max</i>	<i>Min - Max</i>	<i>Minimum</i>
28 - 35°C	7.2 - 7.8	60 - 200*	4.0**

TABLE 4: Waterslide water disinfected with bromine

<i>Pool water temperature</i>	<i>pH</i>	<i>Total alkalinity mg/L</i>	<i>Bromine mg/L</i>
	<i>Min - Max</i>	<i>Min - Max</i>	<i>Minimum</i>
< 26°C	7.2 - 7.8	60 - 200*	2.0
≥ 26°C	7.2 - 7.8	60 - 200*	4.0

NOTES for Tables 3 & 4

* It is recommended that where BCDMH is used as the pool water disinfectant the total alkalinity should be maintained in the range 150-200mg/L.

** For hydrotherapy pools operating at the upper temperature limit and under heavy bather loads it is recommended that the bromine concentration be at least 8.0 mg/L.

ACKNOWLEDGMENTS

This Code was developed by a working party comprising representatives from the following organisations:

- Australian Institute of Environmental Health (S.A. Division)
- Australian Institute of Swimming and Recreation Centre Management (S.A. Division)
- Local Government Association of South Australia, Legal Services
- South Australian Health Commission, Environmental Surveillance Section
- Swimming Pool and Spa Association of Australia (S.A. Division)
- South Australian Swimming Pool and Spa Industry.

The Public and Environmental Health Council wishes to convey its sincere appreciation to the supporting organisations for making a representative available and to each member of the working party for their valued technical contribution.

REFERENCES

Public and Environmental Health Act, 1987 and Regulations.

Australian Standards:

2610 Spa Pools

2610.1 Part 1:Public Spas

2610.2 Part 2:Private Spas

3633 Private Swimming Pools - Water Quality

3979 Hydrotherapy pools

MITCHELL, P. Kirk, *The Proper Management of Pool and Spa Water*. Hydrotech Chemical Corporation.

HARTLEY, K.J., *Chemistry of Chlorinated Swimming Pools*. Gutteridge Haskins and Davey, 1989.

ANTISAVAGE, J.P. (ed) *Handbook of Industrial Water Conditioning*. Eighth Edition, Betz Laboratories, 1980.

Australian Guidelines for Heated Spa Pools, National Health and Medical Research Council, Commonwealth of Australia, 1989.

Australian Guidelines for Disinfecting Private Swimming Pools, National Health and Medical Research Council, Commonwealth of Australia, 1990.

JOLLY, Robert L., BRUNGS, William A., CUMMING, Robert A. *Water Chlorination and Health Effects*. Volume 3, Ann Arbor Science.

Municipal Wastewater Disinfection, Design Manual. United States Environmental Protection Agency, October 1986.