

# HB 241–2002



## Water Management



## for Public Swimming Pools and Spas

2nd Edition



HB 241 - 2002

2<sup>nd</sup> EDITION

# Water Management for Public Swimming Pools and Spas

Second Edition

**COPYRIGHT**

© Standards Australia and Alan Stewart

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Published by Standards Australia International Ltd, GPO Box 5420, Sydney NSW 2001, Australia.

ISBN 0-7337-4881-3

## PREFACE

The aim of this Handbook is to provide public swimming pool and spa owners, managers, executives, operators, engineers, designers and authorities with a clearer understanding and appreciation of water quality management.

The information provided by this Handbook will help those responsible for water quality to:

- comply with local regulations
- accurately monitor physical and chemical water properties
- correctly record relevant data
- troubleshoot, locate and correct physical and chemical problems
- produce high quality and good looking water.

This second edition of the Handbook includes detail on recent automatic chemical dosing, systems, further information on chemical testing and a restructure of some of the text.

The author of this Handbook, Alan Stewart, owns and operates a technology and equipment testing service, 'On Site Water', in Victoria. It provides a service to clients in Melbourne and has assisted in the development of guidelines for water quality. He has published a number of books and articles on water management.

Paul Stevenson MIE Aust, CP Eng of Stevenson and Associates Pty Ltd, Greg O'Connell MAppSc, PhD of Biolab Australia Pty Ltd, Ron King and Michael Moore of Australian Spa and Pool Services, Neil Shaw of the NSW Department of Health, and Derek Lightbody of the Victorian Department of Human Services, provided assistance in the compilation of the first edition this handbook.

### *Revisions and additional material for the second edition:*

Tim Batt of USF Stranco Aquatic Pty Ltd provided details of their pool monitoring and dosing systems and particularly the systems used in the Sydney Olympic venues. Warren Thomas of Palintest provided additional information on chemical testing and both Tim Batt and Warren Thomas provided additional details on water chemistry and methods of correcting imbalance. Gary Penfold of the Warringah Aquatic Centre also provided technical advice in a number of areas.



**CONTENTS**

CHAPTER 1 INTRODUCTION .....	1
CHAPTER 2 VENUE INFRASTRUCTURE .....	3
Venue design .....	3
Venue purpose and facilities .....	3
Pool and spa shell design and water circulation .....	4
CHAPTER 3 WATER STANDARDS – HEALTH REGULATIONS .....	9
What are standards and regulations? .....	9
Supply and replenishment water .....	9
Pool and spa water .....	10
CHAPTER 4 ENGINEERING .....	15
Pre-filter systems .....	15
Skimmer boxes .....	15
Strainers/lint pots .....	15
Balance tanks .....	15
Filter .....	15
Vacuum pre-coat filters .....	18
Sand filters .....	19
Medium-rate sand filters .....	19
High-rate sand filters .....	22
Cartridge filter .....	24
Filter size .....	25
Hydraulic system .....	26
Pumps .....	27
Valves .....	29
Filter/hydraulic system monitors .....	31
Water replenishment .....	32
Heating .....	32
Heat pumps .....	34
Ventilation .....	35
Plant room .....	35
CHAPTER 5 WATER CONDITION – PHYSICAL .....	37
Water load measurement .....	37
Bather load .....	37
Water turnover .....	37
Water temperature .....	38
Water discharge and replenishment .....	38

Spa water .....	39
Water clarity and turbidity .....	39
Coagulation .....	40
Flocculants .....	41
Water filtration .....	43
<b>CHAPTER 6 WATER CONDITION – MICROBIOLOGICAL</b> .....	<b>45</b>
Pool hygiene .....	46
<b>CHAPTER 7 WATER CONDITION – CHEMICAL</b> .....	<b>49</b>
Chemical condition .....	49
Water pollution .....	49
Disinfectant choice .....	49
The halogen group .....	50
Chlorine gas .....	50
Calcium hypochlorite .....	50
Lithium hypochlorite .....	51
Sodium hypochlorite .....	51
Cyanuric acid .....	51
Cyanurated chlorine .....	51
Chlorine dioxide .....	54
Chlorine via electrolyser .....	54
Bromine .....	54
Sodium bromide .....	55
Sodium bromide and ozone .....	55
'Solid bromine' .....	55
Non-halogen disinfectants .....	55
Ozone .....	55
Ozone – fullstream system .....	56
Ozone – slipstream system .....	57
Ozone – low dose systems .....	57
Ultraviolet light (UV) .....	58
Ultraviolet (UV) – ozone .....	59
Ultraviolet (UV)/sodium bromide/sodium hypochlorite .....	60
Alkyl biguanide with hydrogen peroxide .....	60
Super and Shock Chlorination .....	60
Water balance .....	60
Langlier saturation index .....	61
Ryznar Stability Index .....	62
Chemicals and the pool water .....	64
pH .....	64
pH – chlorine relativity .....	64

Water hardness.....	64
Calcium.....	65
Total alkalinity.....	67
Total dissolved solids.....	71
Water balance nomogram.....	71
Hydrochloric acid.....	72
Carbon dioxide (CO <sub>2</sub> ).....	72
Sodium bisulphate.....	73
Sodium carbonate.....	73
Sodium bicarbonate.....	73
Calcium chloride and calcium sulphate.....	73
Hydrogen peroxide.....	73
Sodium thiosulphate.....	73
Aluminium sulphate.....	74
Haloforms.....	74
Oxidisers.....	74
<b>CHAPTER 8 APPLICATION OF CHEMICALS TO THE POOL.....</b>	<b>75</b>
Manual chemical dosing.....	75
Automatic chemical dosing.....	76
Control equipment.....	76
Probes.....	77
Specific chemical dosing.....	79
In line erosion (tablets).....	79
On site dissolving (granules and powder).....	80
Liquid chlorine.....	81
Acid dosing.....	81
Carbon dioxide (CO <sub>2</sub> ).....	81
Flocculant dosing.....	82
<b>CHAPTER 9 WATER ANALYSIS – METHODS AND EQUIPMENT.....</b>	<b>83</b>
Water analysis.....	83
Test strips.....	83
Drop count test kits.....	84
Tablet count test kits.....	84
Disk comparators.....	84
Photometers.....	85
Test procedure—photometers.....	87
Specific tests.....	88
Chlorine/bromine.....	88
Chlorine test using a comparator or photometer.....	89
Bromine test using a comparator or photometer.....	89



Ozone test in the presence of chlorine.....	89
pH.....	89
Total alkalinity.....	90
Calcium hardness.....	90
Cyanuric acid.....	90
Total dissolved solids (TDS).....	91
Sodium chloride.....	91
Urea.....	91
CHAPTER 10 WATER ANALYSIS – INTERPRETATION.....	93
Corrective action.....	93
Disinfectants.....	93
Calcium.....	93
Total alkalinity.....	94
pH.....	94
Total dissolved solids (TDS).....	94
Copper.....	95
Iron.....	95
Sulphate.....	95
Chlorite and chlorate.....	95
Water chemistry and systems support.....	95
CHAPTER 11 SERVICE.....	97
Essential regular service and maintenance.....	97
Each day.....	97
Each week.....	97
Each month.....	98
Each six months to twelve months.....	98
Filters.....	98
Cartridge filters.....	98
Pre-coat (Diatomaceous earth) filters.....	99
Sand filters.....	99
Dosing systems.....	99
Controllers.....	99
Probes.....	99
Probe calibration.....	100
ORP/Redox probes.....	100
High Resolution Redox (HRR) probes.....	100
Amperometric probes.....	100
pH probes.....	101
Conductivity probes (for TDS measurement).....	102
Dosing valves.....	102

Solenoid valves .....	102
Diaphragm valves .....	102
CHAPTER 12 SITUATIONS AND SOLUTIONS – WATER CONDITION.....	103
CHAPTER 13 SITUATIONS AND SOLUTIONS – EQUIPMENT .....	107
CHAPTER 14 BIBLIOGRAPHY AND SOURCES.....	111
Photo sources .....	113
CHEMICALS USED IN POOL MANAGEMENT .....	115
A SAMPLE LOG SHEET.....	117

## LIST OF TABLES

Table 1-Amalgamation of Australian State Health Regulations for Public Swimming Pools and Spas .....	11
Table 2-Pipeline Flow Rates .....	27
Table 3-Bather load — Surface area to depth.....	37
Table 4-Recommended operational water temperatures .....	38
Table 5-Flocculant Dosing Chart.....	42
Table 6-Swimming pool pollutants.....	49
Table 7-Chlorine Dosing Chart.....	52
Table 8-Cyanuric Acid (Stabiliser) Dosing Chart .....	53
Table 9- Saturation Index Factors.....	62
Table 10- Range of applicability for the Saturation Index .....	62
Table 11 — Water characteristics predicted by the Ryznar Stability Index .....	63
Table 12-Cyanuric acid adjustment .....	64
Table 13-pH – Chlorine Relativity Scale.....	65
Table 14-pH Adjustment Dosing Chart .....	66
Table 15-Total Alkalinity-to raise with sodium bicarbonate (if using sodium carbonate ½ quantity) .....	69
Table 16-Total Alkalinity-to lower with hydrochloric acid (if using sodium bisulphate multiply figures below by 1.2 to convert to kilograms).....	69
Table 17-Calcium Hardness Dosing Chart .....	70
Table 18-Free Chlorine Reduction With Hydrogen Peroxide.....	73
Table 19-Free Chlorine Reduction With Sodium Thiosulphate.....	74



## CHAPTER 1 INTRODUCTION



**Figure 1 — Family fun in a wet deck pool**

In Australia there are a large number of public swimming pools and spas, including major aquatic centres, busy gymnasiums and health studios, school and college pools of all capacities, hospitals, infrequently used swimming pools and spas in various accommodation centres and venues like hotels, motels, apartments, clubs, housing groups, retirement centres, and swimming schools using domestic size pools. Generally, if the swimming pool or spa is offered as part of, or as a complete service it is regarded as ‘public,’ whether fees are charged or not. While their usage patterns, capacity and purpose may vary, public pools and spas have one important thing in common – the need for adequate physical and chemical management of their water quality.

Operating a public swimming pool or spa, whether it’s for recreational, teaching or therapeutic use, carries with it a great deal of responsibility. This responsibility is emphasised through current health or human services department regulations which set out the chemical, physical and microbiological water standards that must be maintained.

For effective water quality management, the following factors must be considered:

- venue infrastructure
- water standards and health regulations
- venue engineering
- physical and chemical water analysis.

Other than compliance with local building and engineering requirements, no permit is necessary to design and construct a public swimming pool or spa and there are currently no specifications for swimming pool or spa equipment design or for their operation. There are monitoring services provided by local authorities, usually on behalf of health and human services departments, although these can vary in their effectiveness.

There are no mandatory minimum qualifications for operators and it is left to management to make their own decisions about operator skills. Clearly, there is a need for minimum operator skills and systems operation design parameters to be outlined and enforced by responsible industry bodies and appropriate government health agencies.

The effects of incorrect water chemistry or malfunctioning equipment that result in physical, chemical or microbiological problems are the direct liability of the operating organisation, its management and its



SAI GLOBAL

This is a free 12 page sample. Access the full version online.

The remainder of this document  
is available for purchase online at

**[www.saiglobal.com/shop](http://www.saiglobal.com/shop)**

SAI Global also carries a wide range of publications from a wide variety of Standards Publishers:



Click on the logos to search the database online.