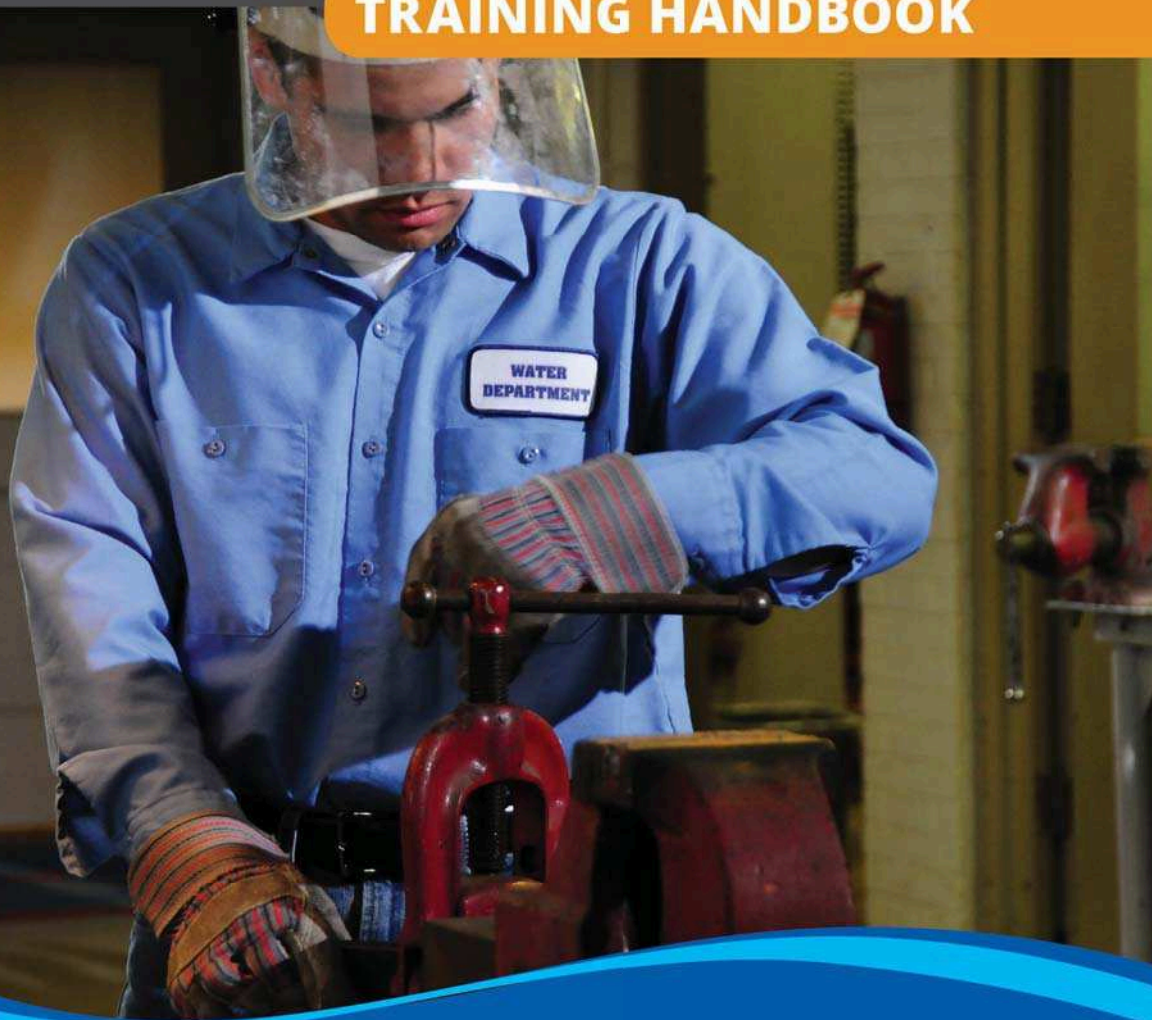


Water Treatment Operator

TRAINING HANDBOOK



American Water Works
Association

Third Edition

Nicholas Pizzi and
William C. Lauer

This is a preview. [Click here to purchase the full publication.](#)

Blank Page

Water Treatment Operator Training Handbook

Third Edition

**Nicholas G. Pizzi
William C. Lauer**



**American Water Works
Association**

This is a preview. [Click here to purchase the full publication.](#)

Copyright © 2002, 2005, 2013 American Water Works Association

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information or retrieval system, except in the form of brief excerpts or quotations for review purposes, without the written permission of the publisher.

Disclaimer

This book is provided for informational purposes only, with the understanding that the publisher, editors, and authors are not thereby engaged in rendering engineering or other professional services. The authors, editors, and publisher make no claim as to the accuracy of the book's contents, or their applicability to any particular circumstance. The editors, authors, and publisher accept no liability to any person for the information or advice provided in this book or for loss or damages incurred by any person as a result of reliance on its contents. The reader is urged to consult with an appropriate licensed professional before taking any action or making any interpretation that is within the realm of a licensed professional practice.

ISBN: 978-1-58321-861-7

Project Manager/Senior Technical Editor: Melissa Valentine

Cover Design: Melanie Yamamoto

Production: Janice Benight Design Studio

Library of Congress Cataloging-in-Publication Data

Pizzi, Nicholas G.

[Water treatment operator handbook]

Water treatment operator training handbook / by Nicholas G. Pizzi and William C. Lauer. -- Third edition.

pages cm

Previous edition published as: Water treatment operator handbook, 2005.

Includes index.

ISBN 978-1-58321-861-7

1. Water treatment plants--Handbooks, manuals, etc. 2. Water--Purification--Handbooks, manuals, etc. I. Lauer, Bill. II. Title.

TD434.P579 2013

628.1'62--dc23

2013009995



**American Water Works
Association**



Printed on
Recycled Paper

Contents

Preface	ix
Chapter 1: Regulated Contaminants and Treatment Challenges	1
Types of Water Systems.....	1
Disinfection By-Product and Microbial Regulations	3
Operational Views of Certain Contaminants	19
Regulatory changes	22
Bibliography	22
Chapter 2: Source Water	25
Sources of Water	26
Source Water Protection Program	31
Source Water Quality Considerations	34
Bibliography	36
Chapter 3: Well Design and Operation	37
Types and Operation of Wells.....	37
Parts of a Well	39
Operations and Maintenance.....	40
Reasons for Well Abandonment	43
Bibliography	44
Chapter 4: Pretreatment	45
Variation in Source Water Quality.....	45
Process Design.....	47
Bibliography	50
Chapter 5: Coagulation and Flocculation	51
Coagulation	52
Common Coagulant Aids	53
Coagulation Chemical Feed Systems.....	54
Process Operations and Maintenance.....	58
Flocculation	63
Bibliography	66
Chapter 6: Sedimentation	67
Process Design.....	68
Types of Basins.....	70
High-Rate Processes	72
Operations and Maintenance.....	77

Safety	79
Residuals	79
Turbidity Testing	85
Bibliography	85
Chapter 7: Filtration	87
Slow Sand Filters	87
Rapid Sand Filters	89
Diatomaceous Earth Filters	91
Granular Bed Designs	92
Granular Bed Operation and Optimization	95
Bibliography	112
Chapter 8: Disinfection	113
Basics of Chemical Disinfection	113
Chlorine Feed Equipment	120
Chlorine Dioxide	120
Chloramination	121
Ozone	123
Ultraviolet Light	124
Disinfection By-Products	126
Bibliography	127
Chapter 9: Softening	129
Water Hardness	129
Precipitative Softening Process	131
Bibliography	145
Chapter 10: Specialized Treatment Processes	147
Aeration	147
Adsorption (GAC)	148
Iron and Manganese Removal	150
Fluoridation of Water	152
Activated Alumina Fluoride Removal Process	157
Adsorptive Media	158
Electrodialysis Demineralization	158
Precoat Filtration (Diatomaceous Earth)	160
Corrosion and Scaling Control	161
Ion Exchange	162
Bibliography	164
Chapter 11: Membrane Systems	165
Reverse Osmosis	165
Nanofiltration	167

Ultrafiltration	168
Microfiltration	168
Post-treatment	169
Future Considerations	170
Bibliography	170
Chapter 12: Testing and Laboratory Procedures	171
Reasons for Testing	171
Sampling	171
Quality Assurance/Quality Control	174
Bibliography	189
Chapter 13: Instrumentation and Control Equipment	191
Process Control	191
Bibliography	205
Chapter 14: Safety and Security Practices	207
Treatment Plant Safety	207
Safety Regulations	207
Confined Space Rules	208
General Plant Safety	211
Lab Safety	217
General Safety	217
Plant Security	217
Bibliography	222
Chapter 15: Record Keeping and Reporting	223
Process Records	223
Reporting	227
Plant Performance Reports	228
Bibliography	229
Appendix A: Sample Material Safety Data for Chlorine	231
Appendix B: Math and Calculation Methods	239
Practical Unit Conversions for Water	239
Practical Water Treatment Plant Example Problems	241
Appendix C: Water Chemistry	251
Appendix D: Metric Conversions	257
Glossary	263
Index	279
About the Authors	293

First Edition Preface

The people who operate water treatment plants make an important contribution to the public health of the community in which they work. A safe drinking water supply is essential to all representative groups within the sphere of influence of the treatment plant. Therefore, the water plant operator should be a trained professional who is capable of performing the tasks necessary to provide the safest possible water.

Trained professional: the phrase implies two principles. First, this is a person who conforms to technical and ethical standards of a discipline, perhaps on the level of a permanent career. Second, this person is trainable and has been trained to perform at a level that leads to professionalism. This book is written with those principles in mind.

An ethical paradigm is in action here. Performing the role of water plant operator places a premium on allegiance to the consumer, the regulator, and the employer. Often, operators believe the demands made on them by the three are in conflict. Many operator training programs are available to people in the field, but few of them offer training in ethics. Occasionally, we read about an operator who has made a questionable ethical choice. Public response to these incidents is a predictable loss of confidence in the drinking water industry. Usually, when operators make the right choice, it is a result of their training. Unfortunately, the right choices that operators make are not often written about.

The US Environmental Protection Agency (USEPA) has published guidelines for the certification and qualification of the men and women who operate the water treatment plants in this country.* These guidelines provide a legal framework for operator certification, one that underscores the opinions previously stated. To add weight to the seriousness of the rule, the USEPA administrator is directed to withhold 20 percent of the funds a state is otherwise entitled to receive in its Drinking Water State Revolving Fund capitalization grants under section 1452 of the Safe Drinking Water Act if the state does not meet goals or commitments. This action is an inducement to perform.

*Federal Register, USEPA, FRL-6230-8, Final Guidelines for the Certification and Recertification of the Operators of Community and Nontransient Noncommunity Public Water Systems, Feb. 5, 1999. p. 5916.

The rule requires, at a minimum, that all owners of public water supplies place the direct supervision of their water system under the responsible charge of an operator(s) holding a valid certification equal to or greater than the classification of the treatment facility. It further requires that all operating personnel making process-control decisions about water quality or quantity that affect public health be certified. Finally, it requires that a designated certified operator be available for each operating shift.

The rule is populated with many phrases that begin with “must”: the state must classify water systems; operators must pass an exam; exam questions must be validated; operators must have a minimum level of schooling; licenses must be renewed; the state must establish training requirements; the state must include ongoing stakeholder involvement.

What drives this rule and its associated requirements? The recognition that the water treatment plant is a barrier against the passage of pathogen-infested or otherwise harmful water and that those who own and operate them should be accountable for the water they produce. The concept of the multiple-barrier approach to water plant operation has evolved from such recognition. Programs such as the Partnership for Safe Water and other efforts attempt to instill a systematic approach to this discipline and to encourage tenacity for ongoing process improvement through optimization. These programs provide a framework for operators who wish to improve their skills and knowledge of the profession.

It is hoped that this third edition will help operators in their search for professionalism.

I would like to thank the following water utility professionals who served as reviewers of this book. Their time is appreciated and their expertise acknowledged.

Christine A. Owen, PhD, Water Quality Assurance Officer, Tampa Bay Water, Clearwater, Fla.

Michael J. Pickel, PE, BS Civil Engineering, Environmental Programs Manager, Philadelphia Water Department, Philadelphia, Pa.

David A. Visintainer, MSCE, Director of Public Utilities and Water Commissioner, City of St. Louis Water Division, St. Louis, Mo.

Melinda L. Raimann, BSEd, CUSA, Assistant Commissioner, Cleveland Division of Water, Cleveland, Ohio

David J. Rexing, BA Chemistry, MBA, Water Quality Research and Development Manager, Southern Nevada Water Authority, Las Vegas, Nev.

Jan C. Routt, BS Microbiology, Director of Water Quality, Kentucky-American Water Company, Lexington, Ky.

I would also like to thank the following individuals for their assistance in developing the outline for this book. Their contribution was thorough and helped to make this work a comprehensive tool for operators: David Talley, Bill Lauer, Joe McDonald, Nelson Yarlott, and Gay Porter De Nileon.

Nicholas G. Pizzi

* * *

Third Edition Preface

Nick Pizzi is my friend and colleague. When AWWA asked me to consider authoring the third edition of this book, the first thing I did was to contact Nick. He explained that he had decided not to participate in the revision and that he was confident that I would provide professional and current information.

Even though I did not work with Nick on this new edition, his hand is evident throughout. Before making his decision not to do this revision, he had provided suggestions for updates and I have included them. Also, I did not tamper with Nick's style. His words reveal a passion for operations excellence that I can only hope to appreciate.

My approach was to update the many references and illustrations to make them current. I also reviewed the operator certification knowledge requirements included in the Associated Boards of Certification (ABC) Need-to-Know criteria. Several state certification boards' (e.g., California, Pennsylvania, and Texas) operator requirements were also added where there were differences. Any topics in these certification requirements that were not already included in the book were added.

The result of these additions and revisions make this book an indispensable reference for all water treatment plant operators and plant managers. The book is equally useful for certification exam studies and as a reference for operations personnel.

I want to thank David Plank, Melissa Valentine, and Alan Roberson at AWWA for their help and support during the publication process. Most of all I want to thank Nick Pizzi for his outstanding book, which I was allowed to supplement.

William C. Lauer