

Total and Free Chlorine Residual Analyzers Online

Maintenance Benchmarking Study

Prepared by **ITA Technical Committee, Maintenance Subcommittee, Task Force on Chlorine Residual Analyzers**

1999

Instrumentation Testing Association

Abstract

This maintenance benchmarking study presents reported instrumentation, control, and automation (IC&A) data received from surveyed water, wastewater, and industrial treatment facilities. In particular, this publication focuses on maintenance practices reported for the treatment process areas of disinfection and effluent. Online total and free chlorine residual analyzer technologies, calibration and maintenance practices, and reported effectiveness of performance and accuracy are analyzed. In addition, typical online total and free chlorine residual analyzer technological specifications; applications; and recommended calibration, maintenance, and installation practices are discussed.

Library of Congress Cataloging-in-Publication Data

Chlorine Residual Analyzers: Maintenance Benchmarking Study prepared by the ITA Technical Committee, Maintenance Subcommittee, Task Force on Chlorine Residual Analyzers under the direction of the ITA Board.

Includes bibliographical references and index.

ISBN 1-58346-003-9

1. Total and Free Chlorine Residual Analyzers Online 2. Maintenance Benchmarking Study 3. Instrumentation Testing Association

MBS99CL-001 1999

Copyright © 1999 by the Instrumentation Testing Association (ITA).

All rights reserved. Printed in the United States of America. No part of this publication may be reproduced or distributed in any form or by any means or stored in a database or retrieval system without the prior written permission of ITA.

Printed in the USA **1999**

Information contained in this work has been obtained by ITA believed to be reliable. However, neither ITA nor its officers and authors guarantees the accuracy or completeness of any information published herein and neither ITA nor its authors shall be responsible for any errors, omissions, or damages arising out of use of this information. This work is published with the understanding that ITA and its authors are supplying information but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought.

Maintenance Benchmarking Study of the Instrumentation Testing Association

The Instrumentation Testing Association (ITA) was established on March 1, 1984. The primary function of ITA is to conduct charitable, educational, and scientific testing for public safety. ITA's mission is to advance the theory and practice of instrumentation and automation for water and wastewater treatment and other public works facilities by promoting the reliability and performance of environmental instrumentation and automation technologies. ITA's mission is designed to advance these services to provide better public water service and enhance public health. ITA carries out its mission by developing and disseminating information on instrumentation and automation technologies and by conducting educational programs in the field of instrumentation and automation.

ITA's Maintenance Subcommittee of the ITA Technical Committee, was developed by the ITA Board to originate and produce maintenance benchmarking studies to address the needs of ITA membership. These reports are intended to provide a basic understanding of maintenance practices and procedures and include reported maintenance requirements, cleaning, calibrating, and cost analysis of surveyed treatment facilities.

IMPORTANT NOTICE

The contents of this publication are for general information only and are not intended to be a standard of the Instrumentation Testing Association (ITA).

No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ITA.

ITA makes no representation or warranty of any kind, whether expressed or implied, concerning the accuracy, product, or process discussed in this publication and assumes no liability.

Anyone using this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

Instrumentation Testing Association Technical Committee

Authorized for Publication by the Board of Directors

Instrumentation Testing Association

The Instrumentation Testing Association is an international nonprofit technical and educational organization dedicated to promoting the understanding, selection, improvement, and cost-effective use of instrumentation and automation applications for monitoring and controlling water, wastewater, and industrial systems. Since 1984, ITA has provided educational and technical services to environmental specialists, including civil, mechanical, electrical, and environmental engineers; scientists; local, state, and government officials; treatment plant operators, technicians, and collection systems personnel; laboratory personnel; chemists; industrial technologists; students; academics; and equipment manufacturers and distributors.

For information on membership, publications, and workshops, contact
Instrumentation Testing Association (ITA)

Tel: (702) 568-1445 Fax: (702) 568-1446

Internet: <http://www.instrument.org>

Preface

The purpose of this publication is to report benchmarking data of online total and free chlorine residual analyzer maintenance practices and procedures for water, wastewater, and industrial treatment applications. The reader of this report is responsible for determining which parameters are of most importance to their application to implement the most suitable maintenance practices and procedures for their respective needs. It is also emphasized that a complete assessment of the information presented herein requires that the report be read in its entirety.

This publication was prepared by the ITA Maintenance Subcommittee, of the ITA Technical Committee, Task Force on Chlorine Residual Analyzers under the direction of the ITA Technical Committee, Maintenance Subcommittee, and Board.

Report authors and reviewers include:

Authors' and reviewers' efforts were supported by the following organizations:

City of Houston, Houston, Texas, USA

City of Roseville, Roseville, California, USA

Columbus Water Works, Columbus, Georgia, USA

EMA Services, Inc., The Woodlands, Texas, USA

Grey Engineering, Inc., Mocksville, North Carolina, USA

Hazen & Sawyer, New York, New York, USA

Water Reclamation District of Greater Chicago, Chicago, Illinois, USA

Washington Suburban Sanitary Commission, Laurel, Maryland, USA

as supported by the following organizations:

City of Fort Worth, Water Pollution Control Group, Fort Worth, Texas, USA
City of Houston, Department of Public Works and Engineering, Houston, Texas, USA
City of Winnipeg, Water & Waste Department, Winnipeg, Manitoba, Canada
Columbus Water Works, Columbus, Georgia, USA
Corporation of the City of Windsor, Windsor, Ontario, Canada
EMA, Inc., The Woodlands, Texas, USA
Grey Engineering, Inc., Mocksville, North Carolina, USA
Hazen and Sawyer, New York, New York, USA
Hopewell Regional Wastewater Treatment Facility, Technical Services, Hopewell, Virginia, USA
Louisville and Jefferson County, Metropolitan Sewer District, Louisville, Kentucky, USA
New York City, Department of Environmental Protection, Elm Hurst, New York, USA
Newport News Waterworks, Newport News, Virginia, USA
Northeast Ohio Regional Sewer District, Cleveland, Ohio, USA
PBS&J, Houston, Texas, USA
Royce Instrument Corporation, Parkesburg, Pennsylvania, USA
Sacramento Regional Wastewater Treatment Plant, Elk Grove, California, USA
Washington Suburban Sanitary Commission, Laurel, Maryland, USA
Water Reclamation District of Greater Chicago, Cicero, Illinois, USA

This publication was made possible through special project funding contributions and in-kind services provided by

Louisville and Jefferson County Metropolitan Sewer District, Louisville, Kentucky, USA

Sacramento Regional Wastewater Treatment Plant, Elk Grove, California, USA

Washington Suburban Sanitary Commission, Laurel, Maryland, USA

Contents

Chapter 1—Introduction	1-1
1.1 Background	1-1
1.2 Survey Procedures	1-1
1.2.1 Distribution	1-1
1.2.2 Response Rate	1-2
1.2.3 Survey Participants	1-2
1.3 Report Format	1-2
 Chapter 2—Total and Free Chlorine Residual Analyzers Online	 2-1
2.1 Total and Free Chlorine Residual Measurement	2-1
2.1.1 Principles of Operation	2-1
2.1.2 Types of Instruments	2-1
2.1.2.1 Amperometric Titration Residual Analyzer	2-2
2.1.2.2 Amperometric Probe Residual Analyzer	2-2
2.1.2.3 Colorimetric Residual Analyzer	2-3
2.1.2.4 Oxidation-Reduction Potential Residual Analyzer	2-3
2.1.2.5 Configuration	2-3
2.1.3 Materials of Construction	2-4
2.1.4 Treatment Processes Affecting Analyzers	2-5
2.1.5 Applications	2-5
2.1.6 Installation Practices	2-6
2.1.7 Calibration Practices	2-6
2.1.8 Maintenance Practices	2-6
2.1.9 New Online Total and Free Chlorine Residual Analyzer Technologies	2-6
 Chapter 3—General Facility and Treatment Process Information	 3-1
3.1 Existing Plant Conditions	3-1
3.1.1 General Facility and Treatment Process Information	3-1
3.1.1.1 General Facility Information	3-1
3.1.1.1.1 Type of Treatment Facility	3-1
3.1.1.1.2 Ownership	3-2
3.1.1.1.3 Plant Staffing	3-2
3.1.1.1.4 Plant-Attended Operation	3-3
3.1.1.2 General Flow and Treatment Characteristics	3-8
3.1.1.2.1 Average Flow	3-8
3.1.1.2.2 Water Treatment Influent Flow Characteristics	3-8
3.1.1.2.3 Wastewater Treatment Influent Flow Characteristics	3-9
3.1.1.2.4 Secondary Treatment	3-9
3.1.1.2.5 Disinfection	3-10
3.1.1.2.6 Advanced Treatment	3-11
3.1.1.3 General Instrumentation, Control, and Automation	3-16
3.1.1.3.1 Plant Control and Automation System	3-16
3.1.1.3.2 Documentation of Instrumentation Maintenance	3-16
 Chapter 4—Maintenance Benchmarking of Total and Free Chlorine Residual Analyzers Online	 4-1
4.1 Benchmarking Survey	4-2
 Chapter 5—Disinfection	 5-1
5.1 Total and Free Chlorine Residual Analyzers Online	5-1
5.1.1 Analyzer Technologies	5-1
5.1.1.1 Units in Service	5-1

5.1.1.2 Years in Service	5-2
5.1.1.3 Installation Practices	5-2
5.1.2 Calibration Practices	5-5
5.1.2.1 Calibration Requirements	5-5
5.1.2.2 Calibration Range	5-6
5.1.2.3 Calibration Frequency	5-6
5.1.3 Maintenance Practices	5-9
5.1.3.1 Automatic Cleaning Devices	5-9
5.1.3.2 Maintenance Frequency	5-10
5.1.3.3 Maintenance Hours	5-11
5.1.3 Reported Effectiveness	5-14
5.1.4.1 Performance	5-14
5.1.4.2 Accuracy	5-14
5.1.4.3 Maintenance Material Cost	5-15
Chapter 6—Effluent	6-1
6.1 Total and Free Chlorine Residual Analyzers Online	6-1
6.1.1 Analyzer Technologies	6-1
6.1.1.1 Units in Service	6-1
6.1.1.2 Years in Service	6-2
6.1.1.3 Installation Practices	6-3
6.1.2 Calibration Practices	6-5
6.1.2.1 Calibration Requirements	6-5
6.1.2.2 Calibration Range	6-6
6.1.2.3 Calibration Frequency	6-6
6.1.3 Maintenance Practices	6-8
6.1.3.1 Automatic Cleaning Devices	6-8
6.1.3.2 Maintenance Frequency	6-9
6.1.3.3 Maintenance Hours	6-10
6.1.3 Reported Effectiveness	6-13
6.1.4.1 Performance	6-13
6.1.4.2 Accuracy	6-13
6.1.4.3 Maintenance Material Cost	6-14
Chapter 7—Summary	7-1
7.1 Summary of Survey Results	7-1
7.1.1 General Facility and Treatment Process Information	7-1
7.1.1.1 Survey Distribution and Response Rate	7-1
7.1.1.2 General Facility Information	7-1
7.1.1.3 General Flow and Treatment Characteristics	7-1
7.1.1.4 General Instrumentation, Control, and Automation	7-2
7.1.1.5 Monitoring Use	7-2
7.1.2 Disinfection	7-2
7.1.2.1 Analyzer Technologies	7-2
7.1.2.2 Calibration Practices	7-2
7.1.2.3 Maintenance Practices	7-2
7.1.2.3 Reported Effectiveness	7-2
7.1.3 Effluent	7-2
7.1.3.1 Analyzer Technologies	7-2
7.1.3.2 Calibration Practices	7-2
7.1.3.3 Maintenance Practices	7-3
7.1.3.3 Reported Effectiveness	7-3
Appendix A—Survey Form	A-1
Appendix B—Survey Participant Listing	B-1
Appendix C—References	C-1
Appendix D—Manufacturer Resource Listing	D-1

List of Tables

Chapter 1—Introduction

Table 1.2.2-1—Survey Distribution and Response Rates	1-2
--	-----

Chapter 2—Total and Free Chlorine Residual Analyzers Online

Table 2.1.5-1—Typical Total and Free Chlorine Residual Analyzer Applications	2-5
--	-----

Chapter 3—General Treatment Facility and Treatment Process Information

Table 3.1.1-1—General Facility Information	3-4
--	-----

Table 3.1.1-2—General Facility Comments	3-7
---	-----

Table 3.1.1.2-1—General Flow and Treatment Characteristics	3-12
--	------

Table 3.1.1.2-2—General Flow and Treatment Comments	3-16
---	------

Table 3.1.1.3-1—General IC&A Information	3-17
--	------

Chapter 5—Disinfection

Table 5.1.1-1—Analyzer Technologies	5-3
-------------------------------------	-----

Table 5.1.2-1—Calibration Practices	5-7
-------------------------------------	-----

Table 5.1.3-1—Maintenance Practices	5-11
-------------------------------------	------

Table 5.1.4-1—Reported Effectiveness	5-16
--------------------------------------	------

Chapter 6—Effluent

Table 6.1.1-1—Analyzer Technologies	6-3
-------------------------------------	-----

Table 6.1.2-1—Calibration Practices	6-7
-------------------------------------	-----

Table 6.1.3-1—Maintenance Practices	6-11
-------------------------------------	------

Table 6.1.4-1—Reported Effectiveness	6-15
--------------------------------------	------

List of Figures

Chapter 2—Total and Free Chlorine Residual Analyzers Online

Figure 2.1.2.5-1—Typical Amperometric Residual Analyzer Configuration	2-4
---	-----

Chapter 3—General Facility and Treatment Process Information

Figure 3.1.1.1.1-1—Type of Treatment	3-2
Figure 3.1.1.1.2-1—Ownership	3-2
Figure 3.1.1.1.3-1—Total Plant Staffing	3-3
Figure 3.1.1.1.4-1—Plant Hours of Attended Operation	3-3
Figure 3.1.1.1.4-2—Plant Days of Attended Operation	3-4
Figure 3.1.1.2.1-1—Average Flow	3-8
Figure 3.1.1.2.2-1—Water Treatment Influent Flow	3-9
Figure 3.1.1.2.3-1—Wastewater Treatment Influent Flow	3-9
Figure 3.1.1.2.4-1—Secondary Treatment	3-10
Figure 3.1.1.2.5-1—Disinfection	3-10
Figure 3.1.1.2.6-1—Advanced Treatment	3-11
Figure 3.1.1.3.1-1—Plant Control and Automation System	3-16
Figure 3.1.1.3.2-1—Instrumentation Maintenance Documentation	3-17

Chapter 4—Maintenance Benchmarking of Total and Free Chlorine Residual Analyzers Online

Figure 4-1—Monitored Treatment Processes	4-1
--	-----

Chapter 5—Disinfection

Figure 5.1.1-1—Analyzer Technologies	5-1
Figure 5.1.1.1-1—Number of Analyzers in Service	5-2
Figure 5.1.1.2-1—Years in Service	5-2
Figure 5.1.1.3-1—Installation Practices	5-3
Figure 5.1.2.1-1—Calibration Requirements	5-6
Figure 5.1.2.2-1—Calibration Frequency	5-6
Figure 5.1.3.1-1—Automatic Cleaning Devices	5-9
Figure 5.1.3.2-1—Maintenance Frequency	5-10
Figure 5.1.3.3-1—Maintenance Hours	5-11
Figure 5.1.4.1-1—Performance	5-14
Figure 5.1.4.2-1—Accuracy	5-15
Figure 5.1.4.3-1—Maintenance Material Cost	5-15

Chapter 6—Effluent

Figure 6.1.1-1—Analyzer Technologies	6-1
Figure 6.1.1.1-1—Number of Analyzers in Service	6-2
Figure 6.1.1.2-1—Years in Service	6-2
Figure 6.1.1.3-1—Installation Practices	6-3
Figure 6.1.2.1-1—Calibration Requirements	6-6
Figure 6.1.2.2-1—Calibration Frequency	6-6
Figure 6.1.3.1-1—Automatic Cleaning Devices	6-9
Figure 6.1.3.2-1—Maintenance Frequency	6-10
Figure 6.1.3.3-1—Maintenance Hours	6-10
Figure 6.1.4.1-1—Performance	6-13
Figure 6.1.4.2-1—Accuracy	6-14
Figure 6.1.4.3-1—Maintenance Material Cost	6-14