This is a preview of "AWWA C652-11". Click here to purchase the full version from the ANSI store.



The Authoritative Resource on Safe Water®

ANSI/AWWA C652-11 (Revision of ANSI/AWWA C652-02)



# Disinfection of Water-Storage Facilities





Effective date: Oct. 1, 2011. First edition approved by AWWA Board of Directors June 15, 1980. This edition approved June 12, 2011. Approved by American National Standards Institute July 12, 2011.

6666 West Quincy Avenue Denver, C0 80235-3098 **T** 800.926.7337 www.awwa.org Advocacy Communications Conferences Education and Training Science and Technology Sections

#### **AWWA Standard**

This document is an American Water Works Association (AWWA) standard. It is not a specification. AWWA standards describe minimum requirements and do not contain all of the engineering and administrative information normally contained in specifications. The AWWA standards usually contain options that must be evaluated by the user of the standard. Until each optional feature is specified by the user, the product or service is not fully defined. AWWA publication of a standard does not constitute endorsement of any product or product type, nor does AWWA test, certify, or approve any product. The use of AWWA standards is entirely voluntary. This standard does not supersede or take precedence over or displace any applicable law, regulation, or codes of any governmental authority. AWWA standards are intended to represent a consensus of the water supply industry that the product described will provide satisfactory service. When AWWA revises or withdraws this standard, an official notice of action will be placed in the official notice section of *Journal AWWA*. The action becomes effective on the first day of the month following the month of *Journal AWWA* publication of the official notice.

#### American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether that person has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review, and users are cautioned to obtain the latest editions. Producers of goods made in conformity with an American National Standard are encouraged to state on their own responsibility in advertising and promotional materials or on tags or labels that the goods are produced in conformity with particular American National Standards.

CAUTION NOTICE: The American National Standards Institute (ANSI) approval date on the front cover of this standard indicates completion of the ANSI approval process. This American National Standard may be revised or withdrawn at any time. ANSI procedures require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036; (212) 642-4900, or e-mailing info@ansi.org.

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.

Copyright © 2011 by American Water Works Association Printed in USA

### **Committee Personnel**

The AWWA Standards Committee on Disinfection of Facilities, which reviewed and approved this standard, had the following personnel at the time of approval:

Betsy Reilley, Chair

#### General Interest Members

K.C. Choquette, Iowa Department of Public Health, Des Moines, Iowa	(AWWA)
D.J. Hartman,* Standards Council Liaison, Greater Cincinnati Water,	
Cincinnati, Ohio	(AWWA)
C.B. Hagar, Carollo Engineers, Phoenix, Ariz.	(AWWA)
J.M. Henderson, West Linn, Ore.	(AWWA)
S. Vidika, Dixon Engineering Inc., Medina, Ohio	(AWWA)
J.S. Wailes, Black Hawk, Colo.	(AWWA)
T.W. Walker, New York State Department of Health, Victor, N.Y.	(AWWA)
M.L. Wentink, Nebraska DHHS DPH, North Platte, Neb.	(AWWA)
K.L. Mercer,* Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
Producer Members	
R.J. Gordhamer, Measurement Technologies Inc., Redmond, Wash.	(AWWA)
User Members	
T.F. Clark, Monroe County Water Authority, Rochester, N.Y.	(AWWA)
L.A. Hensley, Veolia Water Indianapolis LLC, Indianapolis, Ind.	(AWWA)
R.C. Lorenz, Westerville Water Plant, Westerville, Ohio	(AWWA)
T.W.D. MacDonald, Cambridge Water Department, Cambridge, Mass.	(AWWA)
P.M. Marchand, Providence Water Supply Board, Providence , R.I.	(NEWWA)
B. Reilley, Massachusetts Water Resources Authority, Southborough, Mass.	(AWWA)
E.D. Schwartz, New Jersey American Water Hillsborough, N.J.	(AWWA)
J.L. Stapf, Hernando County Utilities, Brooksville, Fla.	(AWWA)
B.L. Whitteberry, Greater Cincinnati Water Works, Cincinnati, Ohio	(AWWA)

<sup>\*</sup> Liaison, nonvoting

This is a preview of "AWWA C652-11". Click here to purchase the full version from the ANSI store.

This page intentionally blank.

## Contents

All AWWA standards follow the general format indicated subsequently. Some variations from this format may be found in a particular standard.

SEC.	PAGE		
Foreword			
Ι	Introduction vii		
I.A	Background vii		
I.B	History vii		
I.C	Acceptance vii		
II	Special Issues viii		
II.A	Information on Application		
	of This Standard viii		
III	Use of This Standard x		
III.A	Purchaser Options and Alternatives. xii		
III.B	Modification to Standard xii		
IV	Major Revisions xii		
V	Comments xii		

1	General
1.1	Scope
1.2	Purpose
1.3	Application
2	References
3	Definitions
4	Requirements
4.1	Materials and Cleaning
4.2	Forms of Chlorine for Disinfection
	Methods of Chloringtion

SEC.	Р	AGE
4.4	Disinfection Procedures When	
	Conducting Underwater	
	Inspection and/or Cleaning of	
	Potable-Water-Storage Facilities	. 8
5	Verification	
5.1	Water Quality Sampling and	
	Testing	12
6	Delivery	13
Арре	endixes	
A	Chlorine Residual Testing	15
В	Chlorine Dosages	17
С	Disposal of Highly Chlorinated	
	Water	19
Tabl	les	
B.1	Amounts of Chemical Required to	
	Give Various Chlorine	
	Concentrations in 100,000 gal	
	(378.5 m <sup>3</sup> ) of Water	17
B.2	Amounts of Chemical Required to	
	Give a Chlorine Concentration	
	of 200 mg/L in Various	
	Volumes of Water	18
C.1	Amounts of Chemical Required	
	to Neutralize Various Residual	
	Chlorine Concentrations in	
	100,000 gal (378.5 m <sup>3</sup> ) of	
	Water	19

This is a preview of "AWWA C652-11". Click here to purchase the full version from the ANSI store.

This page intentionally blank.

### Foreword

This foreword is for information only and is not a part of ANSI\*/AWWA C652.

#### I. Introduction.

I.A. *Background*. This standard describes methods of disinfecting water storage tanks. The disinfecting agents discussed in this standard are chlorine solutions, and several combinations of free chlorine residual and contact time (CT) are provided. The chlorine solutions may be derived from liquid chlorine (Cl<sub>2</sub>), calcium hypochlorite (Ca(OCl)<sub>2</sub>), or sodium hypochlorite (NaOCl).

I.B. *History.* This standard was first approved on June 15, 1980, under the designation ANSI/AWWA D105, Standard for Disinfection of Water Storage Facilities. The 1980 edition was developed from information originally contained in AWWA D102-64, modified to include disinfection of water-storage facilities constructed of steel or other materials. The standard was redesignated ANSI/AWWA C652 with the 1986 edition. It was later revised in 1992 and again in 2002. This edition was approved by the AWWA Board of Directors on June 12, 2011.

I.C. *Acceptance.* In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the original consortium included the American Water Works Association Research Foundation (AwwaRF, now Water Research Foundation<sup>†</sup>) and the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association (AWWA) and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states.<sup>‡</sup> Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health effects of products and drinking water additives from such products, state and local agencies may use various references, including

1. An advisory program formerly administered by USEPA, Office of Drinking Water, discontinued on Apr. 7, 1990.

<sup>\*</sup> American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036. † Water Research Foundation, 6666 W. Quincy Avenue, Denver, CO 80235.

<sup>‡</sup> Persons outside the United States should contact the appropriate authority having jurisdiction.

2. Specific policies of the state or local agency.

3. Two standards developed under the direction of NSF, NSF\*/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.

4. Other references, including AWWA standards, *Food Chemicals Codex*, *Water Chemicals Codex*,<sup>†</sup> and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdiction. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 61 does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of "unregulated contaminants" are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

ANSI/AWWA C652 does not address additives requirements. Thus, users of this standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.

2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.

3. Determine current information on product certification.

#### II. Special Issues.

II.A. *Information on Application of This Standard*. Utilities are increasingly focusing on water storage reservoir management and maintenance as part of preserving distribution system water quality. Disinfection of water storage tanks presents special challenges due to the quantity of water that must be dealt with, the conditions of the water supplied to the tank, and the ability to collect representative samples of the water in the tank.

Disinfection of tanks and other facilities used for drinking water relies on high levels of free chlorine to ensure bacteria and other potential pathogens are inactivated.

<sup>\*</sup> NSF International, 789 N. Dixboro Road, Ann Arbor, M 48105.

<sup>&</sup>lt;sup>†</sup>Both publications available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.

It should be noted that pH and temperature are two important factors affecting the disinfection process. Hypochlorous acid and hypochlorite are the two forms of chlorine present in water at pH greater than 3. Hypochlorous acid has been shown to be significantly more effective than hypochlorite for disinfection. Above pH 9 there is essentially no hypochlorous acid, only hypochlorite. Temperature also affects the effectiveness of disinfection; low temperatures are not as effective as high temperatures for chlorine disinfection. The high chlorine dosages required in this standard are necessary to provide effective disinfection under varying conditions of pH, temperature, and other factors.

Following disinfection and prior to activating the tank for use, water in the storage tank should be tested to determine that it meets expected parameters typical in the system. Consider especially the work done in the tank and appropriate parameters to measure. Test results should confirm that the water quality is appropriate for distribution. Although this assessment is unique for each system, suggested test parameters include pH, alkalinity, turbidity, odor, and specific conductance. If the tank was painted or if epoxy was applied, measuring levels of volatile organic compounds (VOC) or other components of the coating material (such as zinc), may be necessary, noting that the trihalomethanes (THMs) chloroform, bromodichloromethane, dibromochloromethane, and bromoform, which are part of the VOC test, are a result of disinfection, not coating materials, and would be expected to be present. Satisfactory chlorine residual and coliform results are also required.

When collecting samples for analysis of coliform or other parameters, it is important that the sample represent the water quality in the tank. Sample taps need to be clean and sanitary. In some cases, samples may need to be collected from the top of the tank or hatch. When sampling from the top of the tank or hatch, use of a depth sampler may be beneficial to best represent the quality of water that will enter the system.

For bacteriological tests, the results of testing must show no coliform. Given the different test procedures available for coliform analysis, results should be expressed as "confirmed coliform" and should be <1 cfu/100mL, < 1 MPN/100 mL, or "Absent."

While bacteriological testing in accordance with Section 5 is used to verify the absence of coliform organisms and is generally accepted as verification that acceptable disinfection has been accomplished, following sanitary procedures during the course of all work is necessary to ensure the disinfected tank will be ready for activation.

Disinfectants other than chlorine may be appropriate to use. While this standard describes only the use of liquid chlorine, sodium hypochlorite solutions, and calcium hypochlorite, the applicability of other disinfectants should be evaluated. Ozone and

chemical cleaners have been used, and these warrant further investigation. Whichever disinfectant or method is selected, approval from the local regulatory agency is required.

As more frequent inspections and cleaning of reservoirs are required, utilities are turning to methods that minimize downtime and wasted water. Utilities may use methods employing divers or remotely operated vehicles (ROVs) for both inspection and sediment removal. Sec. 4.4 of this standard describes the disinfection procedures and operational considerations for conducting inspection and cleaning in potablewater-storage facilities. It should be noted that any underwater retrieval of remotely operated vehicles with divers must be performed in accordance with all aspects of this standard. When selecting a contractor to perform this type of work, it is essential to evaluate their experience, safety procedures, and methods. Each bidder should be willing to meet the minimum requirements set by this standard for safe performance of the work. This standard includes references to pertinent OSHA regulations. There are specific technical skills a utility should look for when considering a firm for this type of work, such as the following:

• Qualifications for conducting in-service operations in compliance with OSHA.

• Qualifications for inspecting and evaluating steel/concrete/wood or membranecovered reservoirs.

• Resumes for the specific personnel who will perform underwater inspection and/ or cleaning.

Sec. 4.4 does not address the following items, each of which must be specified by the purchaser:

1. The type of inspection to be performed (structural, coating, bottom sediment, cathodic protection, bacteriological, and so forth).

2. The technical requirements of the inspection and/or cleaning.

For additional guidance, refer to AWWA Manual M42, Steel Water-Storage Tanks.

Sec. 4.4 does not attempt to rewrite existing safety standards and relies on the existing applicable OSHA Standards, including but not limited to

OSHA, 29 CFR, Subpart T, Commercial Diving Operations, 1910.401 through 1910.441.

OSHA, 29 CFR, Permit Required Confined Spaces, 1910.146.

**III.** Use of This Standard. This standard describes methods of disinfecting water-storage facilities that are newly constructed, have been entered for construction or inspection purposes, or that continue to show the presence of coliform bacteria during normal operation. In addition, the standard defines disinfection procedures for

underwater inspections because water utilities increasingly are employing divers and remotely operated vehicles to conduct underwater inspections and/or cleaning of inservice potable-water-storage facilities to minimize water loss and downtime normally associated with necessary maintenance. The standard does not describe the type and technical requirements of underwater inspection and/or cleaning or the required skill level of the diving inspector.

A storage facility is defined as a reservoir from which water, without further treatment other than booster disinfection, is supplied directly to the distribution piping system for domestic use. From a practical standpoint, this standard applies to the disinfection of covered storage facilities constructed of steel, concrete, or materials that would provide a similar structure from a water quality standpoint. Because wood may support the growth of coliform bacteria, it is recommended that any submerged wood surface (columns, baffles, and so forth) be coated with epoxy or other durable, effectively impermeable paint or coating approved for domestic water use.

Parts of this standard may be applicable to the disinfection of large, finished-water, open storage reservoirs, such as reservoirs formed by concrete or earth dams, but these applications are incidental, and this standard is not intended to cover those kinds of storage facilities.

Three methods of chlorinating storage facilities are described in this standard. Each utility should decide which method is most suitable for a given situation. In selecting the method to be used, utility personnel should consider the availability of materials and equipment for disinfection, the training of personnel who will perform the disinfection, chlorinated water disposal options, and safety. For example, gas chlorination should be used only when properly designed and constructed equipment is available; makeshift equipment is not acceptable when liquid-chlorine cylinders are used. Spray equipment should be used inside the storage facility only when thorough ventilation is ensured or when appropriate protection is provided using canister-type gas masks or self-contained breathing units. If a chlorination method is selected that requires the storage facility to be drained in order to dispose of highly chlorinated water, thorough consideration should be given to the effect on the receiving environment. If there is any question as to whether a chlorinated-waste discharge may cause damage to fish life, plant life, physical installations, or other downstream water uses of any type, an adequate amount of a reducing agent should be applied to the discharged water in order to thoroughly neutralize the chlorine residual.

It is the responsibility of the user of an AWWA standard to determine that the products and procedures described in that standard are suitable for use in the particular application being considered.

III.A. *Purchaser Options and Alternatives.* This standard is written as though the work will be done by the purchaser's personnel. If the purchaser is contracting for the work to be done, appropriate provisions should be included in the contract agreement to ensure the contractor is specifically instructed as to his or her responsibilities. At a minimum, the purchaser should specify the following:

1. Standard used—that is, ANSI/AWWA C652, Disinfection of Water-Storage Facilities, of latest revision.

2. Whether compliance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, is required.

3. Method of disinfection to be used.

4. Any required disposal and precautions to be taken in disposing of chlorinated water in the storage facility.

5. Bacteriological testing and method to be used.

6. Redisinfection procedure if required.

7. Details of other federal, state or provincial, and local requirements (Section 4).

III.B. *Modification to Standard*. Any modification of the provisions, definitions, or terminology in this standard must be provided by the purchaser.

**IV. Major Revisions.** Major changes made in this revision of ANSI/AWWA C652 are as follows:

1. Several definitions have been added or updated.

2. Addition of Sec. 5.1.1.5, Optional Sampling and Testing.

3. Broad revision of Sec. 4.4.7, Post-inspection chlorine residual, turbidity, and bacteriological testing.

**V. Comments.** If you have any comments or questions about this standard, please call AWWA Engineering and Technical Services at 303.794.7711, FAX at 303.795.7603, write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.

ANSI/AWWA C652-11 (Revision of ANSI/AWWA C652-02)



AWWA Standard

# Disinfection of Water-Storage Facilities

### SECTION 1: GENERAL

#### Sec. 1.1 Scope

This standard for disinfection of water-storage facilities describes materials, facility preparation, application of disinfectant to interior surfaces of facilities, and sampling and testing for the presence of coliform bacteria, chlorine residual, and acceptable aesthetic water quality. The standard also includes disinfection procedures for underwater inspection and/or cleaning of potable-water-storage facilities but does not describe the technical aspects of underwater inspection and/or cleaning. All new storage facilities shall be disinfected before they are placed in service. All storage facilities taken out of service for inspection, repair, painting, cleaning, or other activity that might lead to water contamination shall be disinfected before they are returned to service.

#### Sec. 1.2 Purpose

The purpose of this standard is to define the minimum requirements for the disinfection of water storage facilities, including the preparation of water storage facilities, application of chlorine, procedures for disinfecting underwater inspection and cleaning equipment, and sampling and testing for the presence of coliform bacteria, chlorine residual, and acceptable aesthetic water quality.