

This is a preview of "AWWA D106-2020". Click here to purchase the full version from the ANSI store.

ANSI/AWWA **D106-20**
(Revision of ANSI/AWWA D106-16)

AWWA Standard

Sacrificial Anode Cathodic Protection Systems for the Interior Submerged Surfaces of Steel Water Storage Tanks

Effective date: Aug. 1, 2020.

First edition approved by Board of Directors June 20, 2010.

This edition approved April 20, 2020.

Approved by American National Standards Institute Feb. 4, 2020.



American Water Works
Association



This is a preview of "AWWA D106-2020". [Click here to purchase the full version from the ANSI store.](#)

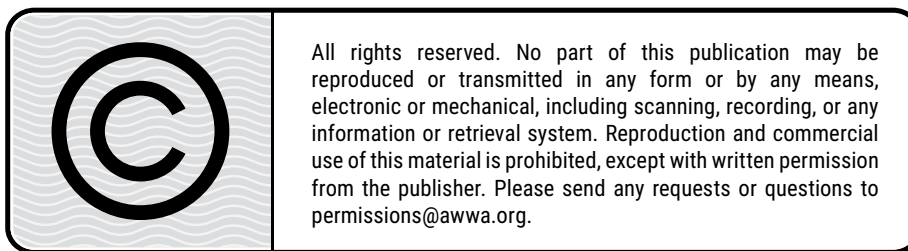
AWWA Standard

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 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 Association*. 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 ANSI approval. 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.



ISBN-13, print: 978-1-64717-013-4

ISBN-13, electronic: 978-1-61300-553-8

DOI: <http://dx.doi.org/10.12999/AWWA.D106.20>

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including scanning, recording, or any information or retrieval system. Reproduction and commercial use of this material is prohibited, except with written permission from the publisher.

Copyright © 2020 by American Water Works Association
Printed in USA

Committee Personnel

The AWWA Cathodic Protection Task Force, which developed this standard, had the following personnel at the time:

David H. Kroon, *Chair*

Miles Steele, *Vice Chair*

C.W. Dessens, City of Houston, Houston, Tex.

C.C. Johnson, Coffman Engineers Inc., San Diego, Calif.

D.H. Kroon, Aegion Corporation, Houston, Tex.

M.P. Parker, Statewide Aquastore Inc., East Syracuse, N.Y.

L.D. Scott, Tank Industry Consultants, Atascadero, Calif.

M. Steele, Aegion Corporation, Atlanta, Ga.

G.R. Stein, Tank Industry Consultants, Indianapolis, Ind.

J.D. Wicoff, Tank Connection, Rogers, Ark.

C. Xiao, City of Phoenix, Phoenix, Ariz.

The Standards Committee on Steel and Composite Water Storage Tanks, which reviewed and approved this standard, had the following personnel at the time of approval:

Gregory R. Stein, *Chair*

User Members

J. Camarena, East Bay Municipal Utility District, Oakland, Calif.

T. M. Dawson, Emerald Coast Utilities Authority, Pensacola, Fla.

M.F. Gaffey, Naval Facilities Expeditionary Warfare Center, Washington Navy Yard, D.C.

N.J. Meder, Connecticut Water Co., Clinton, Conn.

R.B. Potts, Louisville Water Company, Louisville, Ky.

G. Terrell, Birmingham Water Works Board, Birmingham, Ala.

C. Xiao, City of Phoenix, Phoenix, Ariz.

General Interest Members

D.M. Algranti, Albert A. Webb Associates, Riverside, Calif.

J.W. Birkhoff, Birkhoff, Hendricks & Carter LLP, Dallas, Tex.

J.D. Brock, Consulting Services Logistics, Toledo, Ohio

M.M. Coleman (*liaison, nonvoting*), Standards Council Liaison, Wade Trim Associates Inc., Detroit, Mich.

E. Darrimon, Bay Area Coating Consultants Inc., Denair, Calif.

W.J. Dixon, Dixon Engineering Inc., Lake Odessa, Mich.

R.E. Gell, O'Brien & Gere Engineers, Syracuse, N.Y.

M.L. Hickey, Murraysmith, Portland, Ore.

F.S. Kurtz (*liaison, nonvoting*), Standards Engineer Liaison, AWWA, Denver, Colo.

R. Perez, Greeley and Hansen, Indianapolis, Ind.

L.D. Scott (*alternate*), Tank Industry Consultants, Atascadero, Calif.

G.R. Stein, Tank Industry Consultants, Indianapolis, Ind.

J.I. Strand, CBS Squared Inc., Chippewa Falls, Wis.

T.A. Tovey, Jacobs Engineering, Portland, Ore.

Producer Members

C. Brown (*alternate*), Tnemec Company Inc., Kansas City, Mo.

G.A. Burke, Caldwell Tanks Inc., Louisville, Ky.

W.J. Czaska, McDermott, Plainfield, Ill.

J.W. Davis, Tesla NanoCoatings Inc., Massillon, Ohio

K.T. Fuller, Phoenix Fabricators and Erectors LLC, Avon, Ind.

J. Grendzinski (*alternate*), Landmark Structures, Wheaton, Ill.

B.E. Kromer, Tank Builders Inc., Euless, Tex.

K. McGuire, CST Industries Inc., Parsons, Kan.

R.L. Moore, Tnemec Company Inc., St. Louis, Mo.

R. Pawski, Landmark Structures, Wheaton, Ill.

Contents

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

SEC.	PAGE	SEC.	PAGE
Foreword		5	Verification
I	Introduction..... vii	5.1	Inspection and Handling..... 9
I.A	Background..... vii	5.2	Testing 10
I.B	History..... vii	5.3	Operation and Maintenance Manual..... 10
I.C	Acceptance vii		
II	Special Issues viii	Appendices	
II.A	Protective Coatings..... viii	A	Commentary and Additional Information 11
II.B	Cathodic Protection ix	A.1	Scope..... 11
III	Use of This Standard ix	A.2	Determination of Need for Cathodic Protection 11
III.A	Purchaser, Designer and Installer Responsibilities xi	A.3	Principles of Cathodic Protection ... 12
III.B	Modification to Standard xiii	A.4	Design..... 12
IV	Major Revisions..... xiii	A.5	Installation 14
V	Comments xiii	A.6	Energizing the System 14
		A.7	Affidavit of Compliance 14
		A.8	Cathodic Protection and Tank- Mounted Antennas 15
Standard		B	Operation Guidelines for Cathodic Protection Systems 17
1	General	B.1	General 17
1.1	Scope..... 1	B.2	Monitoring..... 17
1.2	Purpose 1	B.3	Records 17
1.3	Application..... 1	C	Service and Maintenance of Sacrificial Anode Cathodic Protection Systems 19
2	References 2	C.1	Scope..... 19
3	Definitions 2	C.2	Annual Inspection and Potential Testing 19
4	Requirements	C.2	Seasonal Anode Service..... 20
4.1	Design..... 5	C.4	Repairs and Replacements 20
4.2	System Components..... 7		
4.3	Installation 8		

This is a preview of "AWWA D106-2020". [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 D106.*

I. Introduction.

I.A. *Background.* This standard describes sacrificial anode cathodic protection systems for the interior submerged surfaces of steel water storage tanks. This standard does not cover automatically controlled impressed current systems (see ANSI/AWWA D104) or impressed current systems with manually controlled rectifiers.

I.B. *History.* Cathodic protection equipment, which was previously included in Section 4 of AWWA D102-64, Painting and Repainting Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage, was not included in AWWA D102-78, Painting Steel Water-Storage Tanks. Therefore, AWWA D104 was developed by the Standards Committee on Steel Elevated Tanks, Standpipes, and Reservoirs to include this information. The first edition of ANSI/AWWA D104 was approved by the AWWA Board of Directors on Jan. 27, 1991. It has gone through a series of revisions since that time. Subsequently, in 2004, the need for a sacrificial anode cathodic protection standard was identified, resulting in the development of AWWA D106. The first edition of the standard was approved by the AWWA Board of Directors on June 20, 2010. The second edition was approved on Jan. 16, 2016. This third edition was approved on April 20, 2020.

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 Water Research Foundation (formerly AwwaRF) 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.[†] 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:

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.

[†] Persons outside the United States should contact the appropriate authority having jurisdiction.

1. Specific policies of the state or local agency.
2. Two standards developed under the direction of NSF*: NSF/ANSI/CAN[†] 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects.
3. Other references, including AWWA standards, *Food Chemicals Codex*, *Water Chemicals Codex*,[‡] 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/CAN 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/CAN 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 D106 does not address additives requirements. 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. *Protective Coatings.* Protective coatings are commonly used in steel water storage tanks. They are an effective method of corrosion control except where flaws exist in the coating caused by poor surface preparation, improper application, defective materials, unanticipated conditions, deterioration over time, or damage. When properly designed and maintained, cathodic protection systems will mitigate corrosion at the submerged locations where there are coating defects, including holidays. A properly applied coating reduces the area of bare steel in contact with the drinking water that requires cathodic protection and reduces the amount of current required to cathodically

* NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

† Standards Council of Canada, 55 Metcalfe Street, Suite 600, Ottawa, ON K1P 6L5 Canada.

‡ Both publications available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.

protect the interior submerged surfaces of the tank. Use and maintenance of protective coatings extend the life of the cathodic protection system and reduce operating costs. For submerged areas of a tank, cathodic protection also reduces the required frequency of coating maintenance. Cathodic protection or coatings can independently reduce corrosion on the interior submerged surfaces; however, the combination of coatings and cathodic protection is normally more economical and effective than using coatings or cathodic protection alone.

II.B. Cathodic Protection. The two major components of a sacrificial anode cathodic protection system are the anodes and the test box for monitoring and current control. In lieu of a test box, the manufacturer may provide an alternative means for monitoring and current control. The range of sacrificial anode output current capacity required for a specific tank is determined by estimating the area of submerged, bare steel to be protected when the interior tank coating is new and when the interior coating has deteriorated to the point where recoating is necessary. In potable water, current density requirements can range from 0.5 to 5.0 mA/ft² (5.4 to 53.8 mA/m²) of bare steel surface. Applications involving turbulence, mixing, high temperature, or a combination of these may require higher current densities. For newly coated tanks, the total current requirement may be as little as 1 percent of the current required to protect an uncoated interior tank surface. As a rule, sacrificial anode systems for newly coated tanks should have sufficient current capacity to protect the anticipated bare submerged surface area before coating repairs or replacement are required.

A sacrificial anode cathodic protection system should include a test box or other means for measuring tank-to-water potentials, instantaneous current interruption, monitoring, and adjusting the current output of the sacrificial anodes. One or more reference electrodes should be included in the system to monitor the protection levels on the submerged steel surfaces. The reference electrode is used to monitor the tank-to-water potential, free of IR drop error. IR drop must be eliminated or minimized to accurately determine the potential between the tank surface and the reference electrode submerged in the tank. The test box allows for the anode current to be instantaneously interrupted, providing an IR drop-free potential that closely approximates the polarized potential of the tank.

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

Contractual responsibilities for items such as design, material, fabrication, construction, safe work practice, inspection, testing, and operation have been removed from the standard and must be addressed in the contract documents.

Many tanks using sacrificial anode cathodic protection systems* for interior submerged surfaces have been in service for more than 30 years. Proper design and maintenance of sacrificial anode cathodic protection systems can significantly extend the service life of steel water storage tanks.

This standard does not cover systems where the purchaser specifies criteria for protection other than those listed in this standard. This standard does not cover systems to be installed in areas subject to regulations or requirements that are more stringent than the requirements contained herein. Where local, municipal, county, or state government requirements apply to the installation of the sacrificial anode cathodic protection system, such requirements govern, and this standard should be interpreted to supplement them. It is the purchaser's responsibility to supplement or modify this standard for compliance with these local requirements.

At a minimum, it is important that all of the requirements in this standard be met. A sacrificial anode cathodic protection system cannot be represented as a system compliant with ANSI/AWWA D106 if it does not meet the minimum requirements of this standard.

Annual inspection and maintenance of the system are important to ensuring maximum tank life.

AWWA Manual M27, *External Corrosion Control for Infrastructure Sustainability*, chapter 6, addresses corrosion and corrosion protection for water tanks; and AWWA Manual M42, *Steel Water Storage Tanks*, provides guidance on inspection and maintenance of steel tanks for water storage.

This standard assumes that the tank owner utilizes procedures or equipment to prevent freezing of the water in the tank. Where the possibility of freezing exists, the owner should implement procedures or equipment to prevent freezing. The purchaser is referred to National Fire Protection Association (NFPA) document NFPA 22, *Water Tanks for Private Fire Protection*, for heater sizing. Purchasers are cautioned against allowing ice to form inside a tank because it may damage system components and even the tank itself.

* The word *system* and the phrase *cathodic protection system* are used hereinafter broadly in place of the lengthy phrase *sacrificial anode cathodic protection system for interior submerged surfaces of steel water storage tanks*.

This standard does not cover tank disinfection procedures or cleaning and painting. ANSI/AWWA C652, Disinfection of Water Storage Facilities, should be consulted for recommended procedures for disinfection of water storage facilities.

III.A. *Purchaser, Designer and Installer Responsibilities.* Proper use of this standard requires the purchaser, purchaser representative or the designer to specify certain requirements. It may be desirable to modify, delete, or amplify sections of this standard to suit special conditions.

III.A.1 Information Specified By Purchaser. The following information should be provided by the purchaser or designated representative when specifying a sacrificial anode cathodic protection system for interior submerged surfaces of a steel water storage tank:

1. Compliance with the latest revision of ANSI/AWWA D106, Sacrificial Anode Cathodic Protection Systems for the Interior Submerged Surfaces of Steel Water Storage Tanks.
2. Compliance requirement for NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects (see Sec. 4.1.2).
3. Location of the site.
4. Gross capacity of the tank, the tank diameter, and the type of roof.
5. For elevated tanks, the style and shape of tank, bottom capacity level (BCL), head range, and the diameter and type of riser.
6. For ground-supported flat-bottom tanks, the maximum water level (MWL).
7. Chemical analysis of the water to be stored, including TDS, conductivity, pH, chloride ion concentration, and sulfate ion concentration.
8. Whether water turbulence caused by filling and/or mixing may exist.
9. Operating temperature range and flow rate range.
10. Type and age of protective coatings.
11. Maximum anticipated coating deterioration expressed as a percentage of the total interior submerged coated surface area that is allowed to become bare before the coating is repaired or replaced (for CP design purposes).
12. Presence and submerged surface area of stainless steel, copper, brass, and metals other than carbon steel in the submerged portion of the reservoir.
13. Required design life of the anode system.
14. Required time for completion of system installation.
15. Where anodes are to be installed and suspended through hand-holes on the top of the tank, it is recommended that the purchaser coordinates anode hand-hole

cutting/painting work sequence with tank steel fabricator and coating contractor, as applicable.

III.A.2 Designer Responsibilities. The CP designer should submit design calculations, specifications, and construction drawings, including installation details of the sacrificial anode CP system (see Sec. 4.1.2). The following information shall be included in the system documentation:

1. Design basis of the system, including tank size and configuration, water properties, type of coatings, and design percentage of bare steel surface to be protected.
2. Anode metal and alloy required (see Sec. 4.1.2.3).
3. Anode dimensions.
4. Spatial location and depth of the anodes within the tank (see Sec. 4.1.2.4).
5. Type and detail of anode connection (see Sec. 4.1.2.4), either:
 - a. Direct connection of the anodes to the tank.
 - b. Connection of the anodes through a test box.
6. Where needed, dimensions of anode hand-holes and sealing mechanism on the tank roof.
7. Anode suspension and support system (see Sec. 4.2.2).
8. Design life of the anode system.

III.A.3 Construction Support. The purchaser or designated representative should provide the following during CP system construction and commissioning:

1. Ingress / egress to the site on which the tank is located, including sufficient space to permit access to install, inspect, and test the system.
2. Any materials to be furnished by the purchaser for installation by the system installer.
3. A sufficient volume of water in the tank at the time of CP system commissioning and testing.

III.A.4 Installer Responsibilities. The system installer should furnish the following items for construction of a Sacrificial Anode Cathodic Protection System for Interior Submerged Surfaces of a Steel Water Storage Tank:

1. Documentation demonstrating regular safety training and a comprehensive safety plan for completing the work.
2. A Certificate of Compliance accompanied by material and equipment catalogue cuts to demonstrate compliance with the CP system design.
3. All labor, equipment and materials, except materials provided by the purchaser, necessary to complete the installation of the system, including inspection and testing required by this standard.

4. Any additional work specified separately by the purchaser in the contract documents.

5. Operation and Maintenance manual.

6. As-built drawings, including all deviations from the original design with respect to location of anodes, reference cells, test box, splices or routing of wire and cables.

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. The major revisions to this edition of the standard include the following:

1. Sec. III.A on Purchaser Options and Alternatives from the 2016 edition has been replaced with a new Sec. III.A on Purchaser, Designer, and Installer Responsibilities.

2. Language regarding dissimilar metals inside the tank below the maximum water level (MWL) has been added (Sec. 4.1.1). Related commentary has been added to Sec. A.4.

3. Requirements for roof hand-hole configuration have been added (Sec. 4.3.1).

4. Numerous editorial revisions have been made throughout the standard to improve clarity.

V. Comments. If you have any comments or questions about this standard, please contact 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 the group at standards@awwa.org.

This is a preview of "AWWA D106-2020". [Click here to purchase the full version from the ANSI store.](#)

This page intentionally blank.



**American Water Works
Association**

Dedicated to the World's Most Important Resource®

ANSI/AWWA D106-20
(Revision of ANSI/AWWA D106-16)

AWWA Standard

Sacrificial Anode Cathodic Protection Systems for the Interior Submerged Surfaces of Steel Water Storage Tanks

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes sacrificial anode cathodic protection systems intended to minimize corrosion of interior submerged surfaces of steel water storage tanks.

This standard does not describe automatically or manually controlled impressed current systems.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for sacrificial anode cathodic protection systems for the interior submerged surfaces of steel water storage tanks, including design, system components, quality of work, installation, operation, and maintenance.

Sec. 1.3 Application

This standard can be referenced in specifications for designing and installing sacrificial anode cathodic protection systems for the interior submerged surfaces of steel water storage tanks. The stipulations of this standard apply when referenced and then only to sacrificial anode cathodic protection systems for the interior submerged surfaces of steel water storage tanks.