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(Revision of ANSI /AWWA D104-01)

American Water Works Association

The Authoritative Resource for Safe Drinking Water®

AWWA Standard

Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks

ANSI American National Standards Institute

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6666 West Quincy Avenue
Denver, CO 80235-3098
T 1.800.926.7337
www.awwa.org

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AWWA Standard

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Committee Personnel

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

David H. Kroon, Chair

Consumer Members

C.W. Dessens, City of Houston, Houston, Texas (AWWA)

Martin Fogata, City of San Diego, San Diego, Calif. (AWWA)

R.J. Kochilla, City of Cleveland, Parma Heights, Ohio (AWWA)

General Interest Members

Lake Barrett, Tnemec Company Inc., Kansas City, Mo. (AWWA)

T.J. McCandless,* Standards Engineer Liaison, AWWA, Denver, Colo. (AWWA)

Producer Members

J.R. Conrady, Conrady Consultant Services, Vero Beach, Fla. (AWWA)

R.V.D. Field, Engineered Storage Products Company, Dekalb, Ill. (AWWA)

R.A. Gummow, Correng Consulting Services, Downsview, Ont. (AWWA)

D.H. Kroon, Corrpro Companies Inc., Houston, Texas (AWWA)

Jeffrey Rog, Corrpro Companies Inc., Medina, Ohio (AWWA)

L.D. Scott, CB&I Trusco Tank, San Luis Obispo, Calif. (AWWA)

The Standards Committee on Steel Elevated Tanks, Standpipes, and Reservoirs, which reviewed and approved this standard, had the following personnel at the time of approval:

Stephen W. Meier, *Chair*

Consumer Members

S.F. Crumb, Fort Worth Water Department, Fort Worth, Texas (AWWA)

W.H. Harris, Houston Public Works and Engineering, Houston, Texas (AWWA)

E.J. King, The Connecticut Water Company, Clinton, Conn. (NEWWA)

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*Liaison, nonvoting

J.L. Ortiz, East Bay Municipal Utility District, Oakland, Calif. (AWWA)

G.A. Weeks, Missouri–American Water Company, Joplin, Mo. (AWWA)

General Interest Members

J.R. Buzek, AEC Engineering, Minneapolis, Minn. (AWWA)

B.R. Conklin, Camp Dresser & McKee Inc., Cambridge, Mass. (NEWWA)

Ed Darrimon, Bay Area Coating Consultant Service, Modesto, Calif. (AWWA)

W.J. Dixon, Dixon Engineering Inc., Lake Odessa, Mich. (AWWA)

S.W. Meier, Tank Industry Consultants, Indianapolis, Ind. (AWWA)

H.J. Miedema, Newport Beach, Calif. (AWWA)

L.F. Peters, Weston & Sampson Engineers Inc., Peabody, Mass. (NEWWA)

J.E. Rudina, Mazda Consultants, Apple Valley, Minn. (AWWA)

C.C. Sundberg, CH2M Hill Inc., Bellevue, Wash. (AWWA)

T.J. McCandless,* Standards Engineer Liaison, AWWA, Denver, Colo. (AWWA)

J.H. Wilber, American AVK, Fresno, Calif. (AWWA)

R.S. Wozniak, Bow Tech Ltd., Batavia, Ill. (AWWA)

Producer Members

Mike Bauer, Tnemec Company Inc., North Kansas City, Mo. (AWWA)

D.G. Cull, CT Services Inc., Jeffersonville, Ind. (AWWA)

J.C. Ellrich, Mid Atlantic Storage Systems Inc., Washington Court House, Ohio (AWWA)

B.E. Kromer, Tank Builders Inc., Euless, Texas (SPFA)

G.A. Larson, CB&I Constructors Inc., Clive, Iowa (AWWA)

K.E. McGuire, Columbian Tectank Inc., Parsons, Kan. (AWWA)

L.D. Scott,† CB&I Trusco Tank, San Luis Obispo, Calif. (AWWA)

D.L. Stilger, Caldwell Tanks Inc., Louisville, Ky. (AWWA)

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*Liaison, nonvoting

†Alternate

Contents

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

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA D104.

I. Introduction.

I.A. *Background.* This standard describes automatically controlled, impressed-current cathodic protection systems for the interior submerged surfaces of water storage tanks. This standard does not cover sacrificial (galvanic) anode-type cathodic protection systems or manually controlled rectifiers.

I.B. *History.* Cathodic protection equipment, which was previously included in Sec. 4 of AWWA D102-64, Painting and Repainting Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage, was not included in ANSI/AWWA D102-78, Painting Steel Water Storage Tanks. Therefore, ANSI/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. The second edition was approved on Feb. 2, 1997. The third edition was approved on June 17, 2001. This edition was approved on June 13, 2004.

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 all direct and indirect drinking water additives. Other members of the original consortium included the American Water Works Association Research Foundation (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

*Persons outside the US should contact the appropriate authority having jurisdiction.

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

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*‡, 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 D104 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 all 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 water storage tanks. They are an effective method of corrosion control except where flaws

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* NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105.

† American National Standards Institute, 25 W. 43rd St., Fourth Floor, New York, NY 10036.

‡Both publications available from the National Academy of Sciences, 2102 Constitution Ave. N.W., Washington, DC 20418.

exist in the coating caused by poor surface preparation, improper application, deterioration over time, or ice damage. When properly designed and maintained, cathodic protection systems will arrest corrosion at flaws in the submerged coated surface. Properly applied coatings reduce the bare surface area requiring protection and reduce the amount of current required to protect the surface. Use and maintenance of protective coatings extends the life of the cathodic protection system and reduces operating costs. For submerged areas of a tank, cathodic protection can also reduce the frequency of coating maintenance. Cathodic protection or coatings alone can reduce corrosion on the interior submerged surfaces; however, the combination of coatings and cathodic protection may be more economical and effective than using coatings or cathodic protection alone.

II.B. *Cathodic Protection.* The two major components of an automatically controlled, impressed-current cathodic protection system are the DC power supply controller (rectifier) and the anode system. The range of output current capacity required for an automatically controlled rectifier in a specific application is determined by assuming 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/ft^2 (0.54 to 53.8 mA/m^2). Some applications involving turbulence or high temperature, or both, 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 surface. As a rule, rectifiers for newly coated tanks should have sufficient current capacity to protect at least 20 percent of the submerged surface area if it were bare. The required operating voltage of a rectifier for a specific tank depends on the current required to provide adequate protection and the total circuit resistance of the system.

Automatically controlled rectifier systems should be used for cathodic protection of water storage tanks. Automatically controlled systems use one or more long-life reference electrodes to monitor the protection levels maintained on the submerged surfaces. The reference electrode continuously monitors the tank-to-water potential, free of IR drop error. IR drop must be eliminated or minimized to accurately determine the voltage between the tank and the reference electrode submerged in the tank. The controller instantaneously interrupts the flow of cathodic protection current, providing an IR drop-free measurement, which closely approximates the polarized potential. The controller compares the measured tank-to-water potential to

a preset value and automatically adjusts the current output of the rectifier. Automatic units include a tank-to-water potential monitoring meter, which can be easily checked by the purchaser.

NOTE: Manually controlled rectifiers are not recommended for use in water storage tanks and are not covered by this standard because they require frequent monitoring, testing, and manual adjustment of the rectifier current output whenever the current requirements change because of changes in water level, coating condition, temperature, water chemistry, water turbulence, or accumulation of polarization films. Failure to adjust rectifier current output can result in corrosion caused by underprotection or coating damage caused by overprotection.

The second major component of an automatically controlled system is the anode system. The anode system includes the anode material and the method of suspending the anode within the tank. The type of anode material and suspension system specified is typically based on the tank's susceptibility to icing conditions.

For tanks subject to icing conditions, a seasonal or a long-life anode system may be used. A seasonal (or temporary) anode arrangement consists of aluminum rods installed and serviced through hand holes in the tank roof. This type of suspension system is susceptible to ice damage. Ice will adhere to some portion of the anode string and tear the anodes loose, causing the system to fail. Because it is anticipated that the anodes will be damaged annually, low-cost aluminum rods are used. While the anode system is intact, the system will operate properly during the more corrosive summer season. In locations subject to freezing temperatures, there is usually a two- to five-month period during the winter when the system may not operate properly because of ice damage. This type of anode system will usually require annual replacement of the anodes and vertical anode suspension system. Anode remnants should be removed from the tank whenever the interior is accessible.

A long-life anode system includes suspension systems that are designed to be more resistant to ice damage and permit the use of long-life anode materials that have a design life of at least 10 years. The potential for ice damage is reduced by attaching the anode material to a buoyant or horizontally submerged radial-type rope system, which is attached to the walls of the tank and prevents the anode system from coming in contact with ice formations. Another type of system compensates for ice damage by attaching the anode material to an extendable element suspended from the tank roof and accessible through hand holes. The extendable element stretches

with the movement of ice and allows the anode to eventually return to its original position.

For tanks not subject to icing conditions, anodes may be suspended from the tank roof without an extendable element or may be horizontally supported from a buoyant, submerged, radial-type rope system.

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.

III.A. *Purchaser Options and Alternatives.* The purchaser should state whether compliance with NSF/ANSI 61 Drinking Water System Components—Health Effects is to be required in addition to the requirements of the Safe Drinking Water Act. The following items should be described in the purchaser's specifications:

1. Standard used—that is, ANSI/AWWA D104, Standard for Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks, of latest revision.
2. Tank dimensions, including height from bottom capacity level to top capacity level.
3. Chemical analysis of water.
4. Type and age of protective coating(s).
5. Percentage of the submerged coated surface area that is expected to become bare before the coating is repaired or replaced.
6. AC power availability and configuration.
7. Whether a service agreement is to be provided. Refer to appendix C.
8. Additional control to limit rectifier output if required (Sec. 4.2.1).
9. Type of anode and anode suspension system (Sec. 4.2.4.1 and 4.2.4).
10. Required design life of anode system. Whether seasonal or long-life and, if long-life, the required design life in years (Sec. 4.2.3).
11. Location of rectifier (Sec. 4.3.1).
12. Whether the constructor is to provide disinfection work (Sec. 4.3.2).

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

IV. Major Revisions. Revisions to this standard in this edition include minor editorial changes throughout the standard.

V. Comments. If you have any comments or questions about this standard, please call the AWWA Volunteer and Technical Support Group (303) 794-7711, FAX (303) 795-7603, or write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.

American Water Works Association

ANSI/AWWA D104-04
(Revision of ANSI /AWWA D104-01)

AWWA Standard

Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes automatically controlled, impressed-current cathodic protection systems intended to minimize corrosion of submerged interior steel surfaces of water storage tanks and 30-in. (750-mm) diameter and larger wet risers of elevated tanks.

This standard does not describe sacrificial (galvanic) anode-type cathodic protection systems or manually controlled, impressed-current systems.

Sec. 1.2 Purpose

The purpose of this standard is to provide purchasers, manufacturers, and suppliers with the minimum requirements for automatically controlled, impressed-current cathodic protection for the interior of steel water tanks, including design, system components, and workmanship and installation.