



**American Water Works
Association**

Erratum to
ANSI/AWWA D110-04
Standard
for
Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks
(January 2005)

The following equation numbering should read as follows:

Text Reference	Correct Reference	Page No.
4-2	4-1	45
4-3	4-2	45
4-4	4-3	45
4-5	4-4	46
4-6	4-5	46
4-7	4-6	46
4-8	4-7	46
4-9	4-8	46
4-10	4-9	46
4-11	4-10	46
4-12	4-11	46
4-13	4-12	47
4-14	4-13	47
4-15	4-14	48
4-16	4-15	48
4-17	4-16	49
4-18	4-17	49
4-19	4-18	49
4-20	4-19	49
4-21	4-20	50
4-22	4-21	50

2 AWWA D110-04 Erratum

4-23	4-22	52
4-24	4-23	52
4-25	4-24	52
4-26	4-25	53
4-27	4-26	53
4-28	4-27	53
4-29	4-28	54
4-30	4-29	54
4-31	4-30	54
4-32	4-31	54
4-33	4-32	57
4-34	4-33	57
4-35	4-34	57
4-36	4-35	57
4-37	4-36	57
4-38	4-37	58
4-39	4-38	58
4-40	4-39	58



**American Water Works
Association**

The Authoritative Resource for Safe Drinking Water®

ANSI/AWWA D110-04
(Revision of ANSI/AWWA D110-95)

AWWA Standard

Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks



Effective date: Feb. 1, 2005.

First edition approved by AWWA Board of Directors June 22, 1986.

This edition approved Jan. 18, 2004.

Approved by American National Standards Institute Dec. 13, 2004.

6666 West Quincy Avenue
Denver, CO 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. 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 on the first page of the classified advertising 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 W. 43rd St., Fourth Floor, New York, NY 10036; (212) 642-4900.

Science and Technology

AWWA unites the drinking water community by developing and distributing authoritative scientific and technological knowledge. Through its members, AWWA develops industry standards for products and processes that advance public health and safety. AWWA also provides quality improvement programs for water and wastewater utilities.

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 © 2005 by American Water Works Association
Printed in USA

Committee Personnel

The AWWA Standards Committee on Concrete Water Tanks, Wire-Wound Prestressed which reviewed and approved this standard, had the following personnel at the time of approval:

Mehdi S. Zarghamee, *Chair*

Kenneth E. Johnson, *Secretary*

Consumer Members

J.L. Forrestall, City of Concord, Concord, N.H.	(AWWA)
L.L. Gamble, City of Maumee, Maumee, Ohio	(AWWA)
W.J. Horst, Montgomery County Sanitary, Kettering, Ohio	(AWWA)
T.A. Larson, Tacoma Water Division, Tacoma, Wash.	(AWWA)
R.J. Metzger, Monroe County Water Authority, Rochester, N.Y.	(AWWA)
J.L. Stapf, City of Wyoming Water Department, Wyoming, Mich.	(AWWA)
W.G. Sullivan, Massachusetts Water Resources Authority, Boston, Mass.	(AWWA)
W.G. Swann, Morristown Water System, Morriston, Tenn.	(AWWA)
P.E. Tomes, Cincinnati Water Works, Cincinnati, Ohio	(AWWA)
C. Whitley, Harlingen Waterworks System, Harlingen, Texas	(AWWA)

General Interest Members

G.R. Allan, DuFresne-Henry Inc., Wilmington, Mass.	(AWWA)
J.W. Birkhoff, Birkhoff Hendricks & Conway, Dallas, Texas	(AWWA)
R.L. Fuller, CH2MHill Inc., Portland, Ore.	(AWWA)
A.J. Geiss, Onondaga County Water Authority, Syracuse, N.Y.	(AWWA)
R.K. Maniktala, Maniktala Associates PC, Liverpool, N.Y.	(AWWA)
J.D. Newell, Turner Collie & Braden Inc., Houston, Texas	(AWWA)
T.J. McCandless,* Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
W.B. Powers, Montgomery Watson, Boston, Mass.	(AWWA)
M.S. Zarghamee, Simpson Gumpertz & Heger Inc., Waltham, Mass.	(AWWA)

*Liaison, nonvoting

Producer Members

J.D. Copley, The Crom Corporation, Gainesville, Fla.	(AWWA)
C.E. Crowley,* Natgun Corporation, Wakefield, Mass.	(AWWA)
M.R. Dykmans* DYK Prestressed Tanks Inc., El Cajon, Calif.	(AWWA)
K.E. Johnson, Natgun Corporation, Wakefield, Mass.	(AWWA)
R.E. Lucero, DYK Incorporated, El Cajon, Calif.	(AWWA)
R.G. Moore, Precon Corporation, Newberry, Fla.	(AWWA)
S.W. Pavlik,* The Crom Corporation, Gainesville, Fla.	(AWWA)
A.E. Tripp, Preload Inc., Hauppauge, N.Y.	(AWWA)
S.J. Waites,* Preload Inc., Hauppauge, N.Y.	(AWWA)

*Alternate

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			2.9	Sealants and Joint Fillers.....	14
I	Introduction.....	vii	2.10	Epoxy Bonding Agent.....	15
I.A	Background.....	vii	2.11	Epoxy Mortar and Grout.....	15
I.B	History.....	vii	2.12	Form Coatings.....	15
I.C	Acceptance.....	viii	3	Design	
II	Special Issues.....	ix	3.1	Notation.....	16
II.A	Intent.....	ix	3.2	Design Method.....	17
II.B	Limitations.....	ix	3.3	Design Loads.....	17
III	Use of This Standard.....	x	3.4	Allowable Stresses.....	19
III.A	Industry Practice and Assumptions.....	x	3.5	Wall Design.....	22
III.B	Purchaser Options and Alternatives.....	xi	3.6	Dome-Roof Design.....	25
III.C	Modification to Standard.....	xiii	3.7	Other Roof Designs.....	30
IV	Major Revisions.....	xiii	3.8	Floor Design.....	30
V	Comments.....	xiv	3.9	Footing Design.....	33
			3.10	Columns.....	33
			3.11	Tank Appurtenances.....	34
			4	Provisions for	
				Earthquake-Induced Forces	
1	General		4.1	Introduction.....	37
1.1	Scope.....	1	4.2	Seismic Design Categories.....	44
1.2	Definitions.....	2	4.3	Seismic Design Loads.....	45
1.3	References.....	4	4.4	Vertical and Horizontal Forces.....	51
2	Materials		4.5	Other Effects.....	53
2.1	Materials.....	7	4.6	Maximum Allowable Stresses and Reinforcement Requirements.....	55
2.2	Concrete and Shotcrete.....	8	4.7	Maximum Allowable Coefficient of Friction.....	55
2.3	Mixing Water.....	9	4.8	Serviceability Requirements.....	56
2.4	Admixtures.....	9	4.9	Foundation Design.....	57
2.5	Reinforcement.....	9	4.10	Minimum Freeboard.....	58
2.6	Elastomeric Materials.....	12	4.11	Design for Seismic Effects of Backfill.....	58
2.7	Duct Material.....	13			
2.8	Concrete and Shotcrete Coatings.....	13			

SEC.	PAGE	SEC.	PAGE
5	Construction Procedures	Figures	
5.1	Scope	1	Example Diaphragm Sheet
5.2	Concrete	2	Joints Between Wall and Dome Edge Ring.....
5.3	Shotcrete.....	3	Typical Floor-Slab Construction Joint.....
5.4	Forming.....	4	Seismic Zone Map of the United States
5.5	Nonprestressed-Steel Reinforcement and Vertical Tendons.....	5	Types of Joints Used Between the Wall and Its Foundation.....
5.6	Prestressing	6	Curve for Obtaining Factor C_W for the Ratio r/H
5.7	Wall Tolerances	7	Curve for Obtaining Factor K_p for the Ratio r/H
5.8	Seismic Cables	8	Curves for Obtaining Factors W_I/W_T and W_C/W_T for the Ratio r/H
5.9	Waterstops	9	Curves for Obtaining Factors X_I/H and X_C/H for the Ratio r/H
5.10	Elastomeric Bearing Pads.....	10	Net Effective Base-Pad Width After Deformation
5.11	Sponge Fillers.....	11	Diaphragm Patching Detail for Type IV Tank Core Wall
5.12	Disinfection	A-1	Adjusted UBC—1997 Design Response Spectrum.....
5.13	Watertightness		
5.14	Repairs.....		
5.15	Tank Backfill		
5.16	Cleanup		
5.17	Electrical Grounding.....		
6	Inspection Procedures	Tables	
6.1	Scope	1	PVC Waterstops
6.2	Field Observation During Construction.....	2	Allowable Stresses in Concrete and Shotcrete.....
6.3	Inspection After Construction	3	Zone Coefficient.....
6.4	Inspection During Routine Maintenance	4	Importance Factor
6.5	Safety	5	Structural Response Coefficient for Type of Tank.....
		6	Soil Profile Coefficient.....
Appendixes			
A	Alternative Method of Analysis Based on UBC 1997.....		
B	Bibliography.....		

Foreword

This foreword is for information only and is not a part of ANSI/AWWA D110.

I. Introduction.

I.A. *Background.* The New England Water Works Association (NEWWA) established a committee in 1958 to prepare a standard specification for the design and construction of prestressed concrete water-storage tanks. The committee submitted a suggested specification to NEWWA in October 1962 as a guide to those in the water industry who wished to consider the use of these tanks.

American Concrete Institute (ACI) Committee 344 concluded eight years of committee work with a report titled Design and Construction of Circular Prestressed Concrete Structures, published in the *ACI Journal* September 1970. This report referred primarily to wire-wound tanks.

I.B. *History.* In the December 1972 issue of *Journal AWWA*, the applicability of the ACI report to water containment structures was discussed in four articles. As a result of these articles and continued discussion on the subject, a standards committee was authorized by the American Water Works Association (AWWA) to develop an AWWA standard for circular, prestressed concrete water tanks.

An AWWA Standards committee on circular, prestressed concrete water tanks was appointed and held its first meeting June 19, 1974. During its first two years, the committee studied the various types of prestressed tanks then in service or under construction and determined that most were of the wire-wound type. Therefore, the committee in 1976 was directed to limit its scope to the wire- and strand-wound prestressed tank wall design. The first edition of this standard incorporated the work of ACI Committee 344 and contained additional requirements and recommendations, specifically for potable and process water, and for wastewater containment structures. The new standard, AWWA D110-86, Standard for Wire-Wound Circular Prestressed-Concrete Water Tanks, was approved by the AWWA Board of Directors on June 22, 1986, and had an effective date of June 1, 1987. The standard has been in use since approval by the American National Standards Institute (ANSI) on Mar. 3, 1987.

The first revision of this standard was initiated by the AWWA Standards Committee during 1990 according to AWWA Standards Council policy. The revised standard ANSI/AWWA D110-95 was approved by the AWWA Board of Directors