ANSI/AWWA D115-17
(Revision of ANSI/AWWA D115-06)

American Water Works Association

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AWWA Standard

Tendon-Prestressed Concrete Water Tanks

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Contents

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

Foreword

This foreword is for information only and is not part of ANSI/AWWA D115.*

I. Introduction.

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

The 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* in September 1970. This report referred to both wire-wound and tendon tanks. After publication of its first report in 1970, ACI Committee 344 could not reach a consensus on a combined report covering both wire-wound and tendon tanks. In 1985 the ACI Committee was divided into two subcommittees and "interim" reports were completed in 1988 for both types of tanks. ACI did not publish these interim reports but made copies available until a consensus could be reached on a recombined report. However, a consensus could not be reached, and in the spring of 1994 ACI Committee 344 was divided into two separate committees, ACI 372 and ACI 373. ACI Committee 373 was disbanded in 2012.

I.B. *History.* In the December 1972 issue of *Journal AWWA*, circular prestressed-concrete water containment structures were discussed in four articles. As a result of these articles and continued discussion on the subject, a standards committee was authorized by the AWWA Standards Council on June 20, 1974, to develop an AWWA standard on circular prestressed-concrete water tanks. The AWWA Standards Committee on Circular Prestressed-Concrete Water Tanks held its first meeting June 19, 1974.

After many meetings and the presentation of many differing viewpoints, this committee decided to defer work on a standard for tendon tanks and to concentrate only on a standard for wire-wound tanks. ANSI/AWWA D110-86, Standard for Wire-Wound Prestressed Concrete Tanks, was published in 1986.

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.
† American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331.

In 1988 the AWWA Standards Council authorized the formation of a new standards committee to develop a standard for tendon-type prestressed-concrete tanks, with the assigned task of developing a standard for the safe, efficient use of tendon-stressing techniques for design and construction of tanks. Subsequently this new AWWA standards committee was formed and held its first meeting on June 21, 1989, under its first chair, Ib Falk Jorgensen.

The first edition of this standard was published in 1996 and incorporated applicable work of ACI and the AWWA standards committee that had developed ANSI/AWWA D110-86. It contained requirements and recommendations, specifically for potable water containment structures prestressed with bonded circumferential tendons.

The second edition was expanded to include tendon-prestressed tanks of rectangular and other shapes, as well as circular. It was approved by the AWWA Board of Directors on Feb. 12, 2006.

This third edition of ANSI/AWWA D115 was approved on Jan. 15, 2017.

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 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

1. Specific policies of the state or local agency.
2. 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.

* Persons outside the United States should contact the appropriate authority having jurisdiction.
† NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

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 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. 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 D115 does not address all material requirements. Users of this standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine materials 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. *General.* This standard reflects a committee consensus of industry practice concerning the design, detailing, and construction of prestressed-concrete water tanks that employ horizontal prestressing tendons in walls. This standard also addresses the use of prestressing tendons in floors, vertically in the walls, and in roofs. Recommended criteria and guidelines are presented to assist engineers in design and construction of both cast-in-place and precast concrete tanks using tendon prestressing, based on the specific detailed experience of the committee members. Engineering principles are tied to existing codes where applicable. Design and construction of prestressed-concrete water tanks are complex, requiring a wide range of special knowledge and experience. This standard represents a sharing of information on the unique aspects of analysis and construction that are encountered in these types of structures.

II.B. *Site-Specific Conditions.* Because of the wide range of site-specific environments, foundation conditions, loadings, and construction conditions

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

throughout North America, this standard should not be expected to apply universally or to produce a cost-effective and maintenance-free structure in every situation. In adapting this standard to obtain the structure's expected service life for the actual conditions that are anticipated, the purchaser and the designer of the tank are advised to carefully study factors affecting the structure.

II.C. *Tendons.* There are three types of tendons used in the floors, walls, and roofs of tendon-prestressed concrete tanks: bonded, unbonded, and precast-pretensioned. Triple corrosion protection is provided for both bonded and unbonded tendons: (1) two-way prestressed-concrete cover, (2) waterproof plastic ducts or sheathing, and (3) rich cement grout or post-tensioning coating material with corrosion-inhibiting additive. The owner should rely on the engineer-of-record to determine the appropriate type of tendon, taking into account the design requirements and local conditions.

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.* It is not the purpose of this standard either to define or recommend contractual relationships or to stipulate contractual obligations, which are all the responsibility of the purchaser. Generally, purchasers may solicit competitive bids for tendon-prestressed concrete tanks by one of two alternative methods.

Under the first method, a qualified engineer is retained by the purchaser to design the structure and prepare construction drawings, specifications, and other contract documents. Competitive bids are then solicited from constructors and suppliers for construction of the tank. In this standard, these are referred to as *purchaser-furnished designs*.

Under the second method, the purchaser prepares performance specifications that require bidding constructors to prepare detailed project designs and specifications and construct the tank according to the approved design. In this standard, these are referred to as *design–construct projects*.

Although the division of information that must be covered in the purchaser's specifications for execution of each project type differs substantially, depending on who is responsible for the tank design, the information that must be supplied by the purchaser to successfully apply this standard is essentially the same for both methods.

ANSI/AWWA D115 does not address matters related to site selection and property acquisition. It has been assumed that the purchaser will have conducted sufficient background work in the form of studies, predesign surveys, subsurface investigations,

and preliminary design work to establish the desired tank site, volume, operating water depth, and elevations. It is also assumed the purchaser will have acquired the property, easements, and rights-of-way necessary for construction of the tank structure and associated pipelines connecting it to the system. Finally, it has been assumed that the purchaser will accomplish and/or provide the following as necessary or appropriate:

1. Whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required for individual components and materials.

2. The site on which the tank is to be built, with adequate space to permit the constructor to erect the structure using customary methods.

3. A predesign site survey and preparation of a site plan showing existing topography, property lines, approximate tank location, setback, encumbrances, details of special construction features, and extent of final site grading.

4. A site geotechnical survey and foundation report, including logs of borings and test pits, and other pertinent soil and geological information, construction criteria for any backfill that may be necessary at a particular site, and foundation design criteria prepared by a professional engineer specializing in soil mechanics, including allowable bearing loads, anticipated total and differential settlements, and the seismic soil profile type.

5. Structure loading conditions, including but not limited to snow, wind, seismic, hydrostatic uplift, and other live loads, depending on the tank's intended use; the amount of earth cover over the tank, if any; the height of backfill against the tank wall, if any; and any other special loading conditions that are anticipated or special criteria on which the tank design is to be based. If, for example, the tank is located in a high-intensity earthquake area and must have an extra safety factor to continue to serve without damage, the purchaser may specify a greater importance factor for earthquake design than described in ACI 350.3 or provide design values for the horizontal acceleration and/or the spectrum velocity.

6. A groundwater drainage and collection system plan.

7. Delivery of electric power and water service to the site.

8. Details of other federal, state or provincial, and local requirements (Section 2).

III.A.1 Information Required for Use of This Standard. The items that follow are either required information or alternative options in the standard that should be considered and covered in the purchase documents, unless the purchaser intends that the choice for a particular option be left to the tank designer's discretion.

1. The standard used, that is, ANSI/AWWA D115, Tendon-Prestressed Concrete Water Tanks, of latest revision.

2. The required tank capacity and either the plan dimensions or operating water depth.

3. The size, material, location, details, cover depths, and limits of responsibility of pipe connections.

4. The required elevation of the overflow weir and freeboard requirements.

5. The size, material, arrangement, and location of the overflow pipe.

6. Finish grade relative to the tank foundation. (Are the tank walls to be completely exposed, partially buried, or completely buried?)

7. Aboveground exterior concrete coatings, if required (Sec. 2.10.1).

8. Below-grade concrete coatings, if required (Sec. 2.10.2).

9. Design loading conditions (Sec. 3.3.1, 3.3.2, 3.3.3, and 3.3.4).

10. Type of roof structure required: flat with column supports or domed (Sec. 3.8, 3.9, and 3.10).

11. Freeze protection requirements (Sec. 3.12).

12. Tank appurtenances required:

    a. Whether a removable silt stop is required.

    b. Arrangement of inlet–outlet piping, including cover depths (Sec. 3.13.1).

    c. Whether baffles are required (Sec. 3.13.1).

    d. Encasement of piping beneath the floor slab (Sec. 3.13.1.3).

    e. Design rates of inflow and outflow for design of overflow and vent systems (Sec. 3.13.2.1 and 3.13.2.5).

    f. Tank drain line (Sec. 3.13.2.3).

    g. Water level gauge or pressure sensor (Sec. 3.13.2.4).

    h. Ventilation requirements (Sec. 3.13.2.5).

    i. Roof openings and hatches (Sec. 3.13.3).

    j. Access ladder and stair requirements (Sec. 3.13.4).

13. Details of other federal, state or provincial, and local requirements (Section 2).

14. Seismic importance factor.

15. Seismic soil classification from geotechnical foundation survey provided by the purchaser (Section 4).

16. Seismic spectral response accelerations, S_1 and S_S, to be used for the tank design.

17. Watertightness criteria (Sec. 6.1.4).

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

V. Major Revisions. The major revisions made to the standard in this edition include the following:

1. External tendon-prestressed circular tanks with a shotcrete covercoat are no longer covered within the scope of this standard.
2. Section 1 references have been updated.
3. The term *core wall* has been removed from the standard.
4. The term *shotcrete* has been added to the listing of definitions (Sec. 1.2, item 8).
5. References to ACI 301 have been changed to ACI 350.5, Specifications for Environmental Concrete Structures.
6. References to ACI 318 have been changed to ACI 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
7. Material requirements for prestressing tendons and anchorages have been updated (Sec. 2.4).
8. Material requirements for ducts, sheathing, and elastomeric materials for waterstops, bearing pads, and sponge filler have been updated (Sec. 2.5, 2.6, and 2.7).
9. Sec. 2.11, Steel Corrosion Inhibitor, from the 2006 edition (ANSI/AWWA D115-06) has been removed from the present standard.
10. Requirements for NSF/ANSI 61 certification for concrete coatings, form coatings, interior liners, and sealants have been added (Sec. 2.10 and 2.11).
11. The inclusion of ACI 350 durability factor has been added to the design method (Section 3).
12. Allowable stresses in concrete, prestressed reinforcement, and nonprestressed reinforcement have been updated (Sec. 3.4).
13. The minimum thickness of membrane concrete slabs has been changed to 4 in. (Sec. 3.6).
14. Requirements for floor compressive stress, shrinkage and temperature reinforcement, construction joints, and subgrades have been updated (Sec. 3.6).
15. Design provisions for walls, concrete roofs, and dome roofs have been updated (Sec. 3.7, 3.8, and 3.9).
16. Concrete and shotcrete requirements have been updated (Sec. 3.11).
17. Provisions for tank appurtenances—inlet and outlet piping, tank overflows and drains, vents, and ladders and stairs—have been updated (Sec. 3.13).
18. Major revisions to earthquake design considerations have been made (Section 4). A section on Notation has been added (Sec. 4.1.3).

19. Qualifications for installation supervisors and other personnel have been updated (Sec. 5.2.4 and 5.3.6).

20. Provisions for grouting of prestressing tendons have been updated (Sec. 5.2.4.5).

21. Provisions for concrete placement have been updated (Sec. 5.2.5 and 5.2.6).

22. Provisions for precast concrete have been updated (Sec. 5.3).

23. Tolerance requirements have been updated (Sec. 5.6).

24. Watertightness criteria, testing, and repairs have been updated (Section 6).

25. A section on Affidavit of Compliance has been added (Section 8).

26. A section on Additional Design Considerations for roof openings, ladders and stairs, floors, and sponge rubber fillers has been added as appendix C.

27. Editorial clarifications have been made throughout the standard.

VI. Comments. If you have any comments or questions about this standard, please call the AWWA Engineering and Technical Services at 303.794.7711, FAX at 303.794.7603; write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098; or email at standards@awwa.org.

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AWWA Standard

Tendon-Prestressed Concrete Water Tanks

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes current and recommended practice for the design, construction, and field observations of concrete tanks using internal tendons for prestressing. This standard applies to containment structures for use with potable water, raw water, or wastewater.

Sec. 1.2 Definitions

The following definitions shall apply in this standard:

1. *Epoxy bonding agent:* An epoxy used in repair processes to bond fresh plastic concrete mix, mortar, or epoxy mortar to hardened concrete.

2. *Epoxy mortar:* An epoxy mix used for repair of concrete.

3. *Horizontal wall joints:* Connection between the tank's wall and its foundation or floor slab or roof or dome. Types of joints may be generally defined as shown in Figures 2 and 3.

4. *Joint restraint conditions:* Top and bottom boundary conditions for the tank wall.

   a. Changing restraint: A joint may be of a different type during and after prestressing. An example is a joint that is unrestrained during prestressing but is hinged after prestressing. The change in joint type is a result of