

ANSI/AWWA **D100-21**
(Revision of ANSI/AWWA D100-11)

AWWA Standard

Welded Carbon Steel Tanks for Water Storage

Effective date: Nov. 1, 2021.

First edition approved by Board of Directors June 26, 1941.

1995 edition approved Jan. 25, 2021.

Approved by American National Standards Institute Jan. 28, 2021.



American Water Works
Association



AWWA Standard

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ISBN-13, print: 978-1-64717-051-5

ISBN-13, electronic: 978-1-61300-594-1

DOI: <http://dx.doi.org/10.12999/AWWA.D100.21>

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA D100.

I. Introduction.

I.A. *Background.* In 1931, American Water Works Association (AWWA) Subcommittee 7H, whose members were L.R. Howson, H.C. Boardman, and James O. Jackson, prepared “Standard Specifications for Riveted Steel Elevated Tanks and Standpipes.” The specifications were published in the November 1935 edition of *Journal AWWA*. In 1940, the scope of the standard specifications was expanded to include welded construction. The American Welding Society (AWS)[†] cooperated in the revision and became a joint sponsor of the standard. Since its original publication, the standard has gained wide acceptance in the United States and abroad.

I.B. *History.* In 1965, Appendix C was added to provide for the alternative use of higher-strength steels for standpipes and reservoirs. Other changes included the addition of requirements for the use of steel pipe as tubular columns and a wind-pressure formula for winds in excess of 100 mph (45 m/s). The requirements for loads on balconies and ladders and unit stresses for combinations of wind, seismic, and other loads were clarified. The rules for the minimum thickness of shell plates for standpipes and reservoirs were revised to apply only to cylindrical shells and not to roof knuckles or toroidal or elliptical roof plates containing water. The swivel ladder for standpipes and reservoirs, which was found to be impractical, was eliminated, and a fixed ladder was required. The rules for welding and for weld qualification were rewritten completely. The qualification procedure of the American Society of Mechanical Engineers (ASME)[‡] Boiler and Pressure Vessel Code, Sec. IX, was adopted, and the sizes of fillet welds in the shell-to-butt joints of standpipes and reservoirs were revised, as were the sections on sand cushions and grouting for standpipe and reservoir bottoms. Rules for inspection of welds were rewritten completely. An isothermal map showing the lowest one-day mean temperature in various parts of the continental United States and parts of Canada was included. Concrete foundation design was brought into conformity with American Concrete Institute (ACI)[§] Standard No. 318, Building Code Requirements for Reinforced Concrete.

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

† American Welding Society, 8669 NW 36 Street, Suite 130, Miami, FL 33166.

‡ The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016.

§ American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331.

In 1973, the use of rivets for joints in tank shells was eliminated. Specifications for tank steels were revised to include low-alloy steels. The design of foundations for elevated tanks and standpipes was changed extensively, making foundation design a part of the requirements. Procedures for soil investigation were recommended.

In 1979, Appendix A, Non-Mandatory Seismic Design of Water Storage Tanks, and Appendix B, Diagrams for Checking Overturning of Elevated Tanks, were added. The sections from the former Appendix B, covering information to be provided, were incorporated into Sec. II of the foreword, and the sections dealing with foundations were incorporated into Sec. 12. Sec. 11 was revised to include inspection and testing requirements that were formerly in Sec. 11 and Sec. 12 and appendixes A and B. Other additions included requirements for additional acceptable steels, design requirements for seismic resistance, a formula for cylindrical shell design, requirements for backfill within ringwall foundations, and requirements for depth-of-pipe cover. The out-of-date porosity charts in former Appendix A were eliminated and reference made to the charts in the ASME Boiler and Pressure Vessel Code, Sec. VIII, or to the identical charts in American Petroleum Institute (API)[†] Standard 650, Welded Tanks for Oil Storage. A section covering permissible inspection by air carbon arc gouging was added to Sec. 11. Materials for shell plates and intermediate stiffeners were classified into three categories in Appendix C, and the requirements for impact testing were expanded.

In 1984, revisions included new sections pertaining to single-pedestal tanks incorporating design rules for this type of tank. New design rules were included for columns of elevated tanks having eccentric work-point connections. A section covering the design considerations for struts was added. For combined stresses, the unit stresses for wind and seismic forces were increased from 25 percent to 33 $\frac{1}{3}$ percent. Shell plates thicker than 2 in. (51 mm), conforming to ASTM** A36, Specification for Structural Steel, were allowed to be used, provided that their usage was in compliance with certain stipulated conditions and requirements. Ground-supported tanks not greater than 50 ft (15.2 m) in diameter were allowed to have a minimum shell thickness of $\frac{3}{16}$ in. (4.8 mm). A minimum size and maximum spacing were added for foundation bolts. The previous Appendix A, on seismic design, was incorporated into the standard as Sec. 13. In addition, a new section was added to Sec. 13 to permit scaling down to specific site response spectra when local seismic data are available.

[†] American Petroleum Institute, 1220 L Street NW, Washington, DC 20005.

^{**} ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

Appendix C, Alternative Rules and Design Stresses for the Use of Steel Plates and Shapes with Suitable Toughness and Ductility for Use in Welded Standpipes and Reservoirs at Specified Minimum Ambient Temperatures, was made a part of the standard while retaining its title designation as Appendix C.

For Appendix C tanks with a height-to-diameter (H/D) ratio of 0.50 or less, the shell design was allowed to be by the Variable Design Point Method, in compliance with API 650. Also, for Appendix C tanks, inspection of certain members is not required when the material has a tensile strength less than 75,000 psi (517.1 MPa).

In 1996, revisions included new requirements for high-strength anchor bolts. Table 1 was added to clarify thickness limitations and special material requirements. Requirements for wind escalation for heights greater than 125 ft (38.1 m) and wind loads on shrouds were added. Fixed-percentage seismic design loads were eliminated. Design requirements for handrails and guardrails were added. Allowable-unit stresses were stated as a function of material class, which is a function of material yield strength. Width-to-thickness limitations were added for compression elements, and compression requirements for shells were clarified. Design rules for tension and compression rings were added. Anchorage requirements were expanded, and a wind overturning check for ground-supported tanks was added. Weld inspection for tension bracing for cross-braced, column-supported elevated tanks was expanded to include ultrasonic testing and tensile tests. Requirements for flush-type cleanout fittings for ground-supported flat-bottom tanks were added. Design rules and limits for openings in support pedestals were added. Criteria for accessories including safety grills, overflows, and vents were updated. Seal welds were defined and usage clarified. Temperature requirements for welding and weld reinforcement limits were added. Tolerances were added for ground-supported tanks and shells designed by stability formulas. Responsibilities of the certified welding inspector were defined. Inspection requirements for primary and secondary stressed joints and tubular support columns were clarified. Inspection requirements were added for single-pedestal columns and large-diameter dry risers. The penetrometer techniques and details were revised to conform to ASME criteria.

The load factor to be applied to water load for foundation design was clarified, and requirements for material under bottom plates of ground-supported tanks were added.

Seismic design load equations were revised to follow the Uniform Building Code^{††} format. A new seismic map of the United States was included along with new and revised equations for calculating such things as hydrodynamic seismic hoop tensile

^{††} Uniform Building Code, International Conference of Building Officials, 5360 Workman Mill Road, Whittier, CA 90601.

stresses and sloshing wave height to determine minimum freeboard for ground-supported flat-bottom tanks.

Appendix C of the previous edition was incorporated in the standard as Sec. 14, and reference standards were moved to Sec. 1. Electrode criteria and requirements for permanent and temporary attachment criteria were revised. The type of inspection and number of weld-joint inspections were updated to improve quality control.

A new Sec. 15, entitled Structurally Supported Aluminum Dome Roofs, was added.

In 2005, the title and scope of the standard were revised to address only new tanks constructed of welded carbon steel that are used to store water at atmospheric pressure. All contractual language was removed, and nonmandatory requirements were moved to Appendix A as commentary. Specific editions were added for all references. Wind loads were revised to align with ASCE^{††} 7-05. Two new methods (Methods 2 and 3) for determining the allowable local buckling compressive stress for shells were added. Method 3 permits an increase in the allowable stress due to pressure stabilization and is based on a nonlinear buckling analysis. Method 2 permits a partial increase in the allowable stress due to pressure stabilization. The existing method for determining the allowable local buckling compressive stress was renamed Method 1. For roof rafters designed for roof live load of 50 lb/ft² or less, allowable stresses were limited to those of ASTM A36 material. For roof rafters designed for roof live load greater than 50 lb/ft², higher allowable stresses may be used when using a material with minimum specified yield strength greater than ASTM A36 material. Extensive requirements were added for anchor bolts and anchor straps. The thickness to which corrosion allowance is added was changed to the thickness determined by design for elements other than bottom plate of ground-supported flat-bottom tanks. A minimum width requirement was added for butt-welded annulus plates. The requirement that welded splices in tension bracing for multicolumn tanks must be designed for 100 percent joint efficiency was clarified. The 1/16-in. (1.6-mm) additional shell thickness requirement for flush-type cleanouts was eliminated to match the current requirements of API 650. The requirement that inlet protection be removable was added for elevated tanks. Electrical isolation requirements were added for dissimilar metals inside the tank below the MWL.

Sec. 6 (AWWA D100-96), titled Sizing of Ground-Supported Standpipes and Reservoirs, was deleted.

The full-size proof test requirement for the qualification of welding procedure specifications for tension-bracing splice welds was increased to 4/3 times the published

^{††}American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191.

minimum yield strength of the bracing member. Minimum fillet weld size requirements relative to root opening were clarified, and a maximum root opening requirement ($\frac{3}{16}$ in. [4.76 mm]) was added. Seal-welding requirements for corrosion protection and preheat requirements were clarified. Inspection based on sectional segments was deleted. The requirement that welds be visually inspected and acceptance criteria were added. Measurement and documentation requirements for shells designed by Method 2 or 3 were added. Qualification of welder and production testing requirements were added for tension-bracing splice welds. The proof test for tension-bracing splice welds was increased to $\frac{4}{3}$ times the published minimum yield strength of the bracing material.

For foundations, a one-third increase in the allowable bearing stress for wind loads when specified in the geotechnical report was added.

Seismic loads were revised to align with the seismic load requirements of FEMA^{§§} 450 and proposed ASCE 7-05, which are based on a maximum considered earthquake ground motion for an event with a 2 percent probability of exceedance within a 50-year period (recurrence interval of approximately 2,500 years). General and site-specific procedures for determining design response spectra were included. Alternate procedures for elevated tanks and ground-supported flat-bottom tanks were added and allow the use of soil-structure and fluid-structure interaction. The requirement that P-delta effects be considered was added for all elevated tank styles. Vertical design acceleration requirements were specified and are now mandatory for all tanks. A critical buckling check for pedestal-type elevated tanks was added to guard against premature buckling failure. Equations were added to calculate the overturning moment for mat or pile cap foundations supporting flat-bottom tanks. Minimum freeboard requirements similar to those of ASCE 7-05 were added for ground-supported flat-bottom tanks. Piping flexibility requirements similar to those of ASCE 7-05 were added for all tanks.

Appendix A, Commentary for Welded Carbon Steel Tanks for Water Storage, was added to provide background information for many of the requirements contained in the standard. Recommendations for antennas and related equipment were included.

Appendix B, Default Checklist, was added to assist users of the standard.

In 2011, revisions included corrections, updates, and new material to clarify some of the existing requirements.

Sec. 1 was revised to show the latest edition of references.

Sec. 3 was revised to match the wind exposure definitions of ASCE 7-05. The requirement that dome roofs constructed of aluminum shall comply with ANSI/

^{§§}Building Seismic Safety Council, 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005.

AWWA D108 was added. The stress evaluation procedure of ASME BPVC Sec. VIII, Div. 2, was added as an acceptable method for evaluating local shell or pedestal stress for anchor chair designs that are based on a detailed analysis.

Sec. 10 was revised to include an erection tolerance multiplier for elements of ground-supported flat-bottom tanks that are designed in accordance with Sec. 3.4.3 and subject to small compressive stresses.

Sec. 11 was revised to make leak testing of the bottom-to-shell joint mandatory for all ground-supported flat-bottom tanks.

Sec. 13 was revised to not require a site response analysis for short-period structure located on liquefiable soils. The site-specific procedure of FEMA 450 was deleted, and the site-specific procedures of ASCE 7-05 were referenced. The scaling requirement for the alternate procedures was clarified.

Sec. 14 was revised to clarify the thickness and design metal temperature requirements for Category 1 and Category 2 materials when impacts are provided.

Sec. 15, covering dome roofs constructed of aluminum, was deleted and replaced with a reference to ANSI/AWWA D108.

The major revisions in this edition are summarized in Sec. IV of this foreword.

The last edition was approved by the AWWA Board of Directors on Jan. 23, 2011. This edition was approved on Jan. 25, 2021.

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.⁴⁴ 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.

⁴⁴Persons outside the United States should contact the appropriate authority having jurisdiction.

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 D100 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. This standard has no applicable information for this section.

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, inspection, and testing need to be addressed by the purchaser.

^{***} 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.

This standard is based on the accumulated knowledge and experience of purchasers and manufacturers of welded steel tanks.*

Many tanks built in compliance with the first edition of this standard are more than 75 years old and are still in service. Properly operated and maintained welded steel water tanks can have an almost unlimited service life.

III.A. *Purchaser Options and Alternatives.* Proper use of this standard requires that the purchaser specify certain basic requirements. The purchaser may desire to modify, delete, or amplify sections of this standard to suit special conditions. It is strongly recommended that such modifications, deletions, or amplifications be made by supplementing this standard. This standard is not intended to cover storage tanks that are to be erected in areas subject to regulations that are more stringent than the requirements contained herein. In such cases, local regulations supersede the requirements of this standard. Where local, municipal, county, or state government requirements exist, such requirements are to 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. In addition, the purchaser is to provide clarification of the governing codes where they do not clearly refer to tanks, but where the purchaser intends such stipulations to apply to the tank under contract. As an example, if a governing code stipulates a building roof snow load of 40 lb/ft² (1,915 N/m²) and it is intended that the tank roof be designed for this load, the purchaser is to include this as a clarification.

The details of design and construction covered by this standard are minimum requirements. At a minimum, it is important that all of the design conditions in this standard be met.† A tank cannot be represented as an ANSI/AWWA D100 tank if it does not meet the minimum requirements of this standard.

The foundations of tanks are one of the more important aspects of tank design; detailed requirements are covered in Sec. 12. The purchaser should obtain an adequate soil investigation at the site, including recommendation of the type of foundation to be used, the depth of foundation required, and the design soil-bearing pressure. This information should be established by a qualified geotechnical engineer.

* The word "tanks" is used hereinafter broadly in place of the lengthy phrase "elevated tanks, standpipes, and reservoirs for water storage."

† Dawe, J.L., C.K. Seah, and A.K. Abdel-Zaher. 1993. Investigation of the Regent Street Water Tower Collapse. *Journal AWWA*, 93(5):34–47.

A drainage-inlet structure or suitable erosion protection should be provided to receive discharge from the tank overflow. The overflow should not be connected directly to a sewer or a storm drain without an air break.

Annual inspection and maintenance of the exposed side of the tank shell-to-bottom connection for a standpipe or reservoir is important if maximum tank life is to be attained. In particular, accumulations of dirt and weeds, which may trap moisture and accelerate corrosion, should be removed. Inspection of the interior and exterior of the entire tank with corrective maintenance at three-year intervals is recommended. Refer to AWWA Manual M42, *Steel Water-Storage Tanks*, for guidance concerning inspection and maintenance of welded steel tanks for water storage.

This standard assumes that the purchaser (owner) provides sufficient water replacement and circulation to prevent freezing in the tank and riser pipe. Where low usage may result in the possibility of freezing, water may need to be wasted or heat provided to prevent freezing. The purchaser is referred to National Fire Protection Association (NFPA)[‡] document NFPA 22, Standard for Water Tanks for Private Fire Protection, for heater sizing. Purchasers are cautioned against allowing ice buildup for insulation, which may break loose and damage the tank.

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. Often, it is desirable for the purchaser to perform the disinfection to eliminate the necessity for the painting constructor to return afterward or to stand by until the inside paint has dried completely. If disinfection is to be done by either the tank or painting constructor, the purchaser must specify the manner in which disinfection is to be done.

The following recommendations are believed to represent good practice, but they are not requirements of ANSI/AWWA D100. When a welded steel tank is to be purchased under this standard, the purchaser should provide the following:

1. The site on which the tank is to be built, including sufficient space to permit the structure to be erected by customary methods.
2. Water at the proper pressure for testing, as required, and facilities for disposal of wastewater after testing.
3. A suitable right-of-way from the nearest public road to the erection site.
4. Materials furnished by the purchaser to be used by the constructor for construction of the tank.

[‡] National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169.

5. A geotechnical investigation of the project site that provides the information listed in Sec. 12.2.1.

The constructor should provide the following items:

1. Foundation and tank design, drawings, and specifications.
2. All labor and materials, except materials provided by the purchaser, necessary to complete the structure, including the foundations, accessories, and testing required by this standard.
3. Any additional work, separately specified by the purchaser, such as painting and disinfection.

Variations in the responsibilities of both the purchaser and the constructor, as previously outlined, may be made by contractual agreement. The purchaser and the bidder should each provide the information identified in the following listings.

III.A.1. Information to Be Provided by Purchaser for an Elevated Tank. This standard provides minimum requirements for the design, construction, inspection, and testing of the tank without any designation of which party must perform these tasks. For this reason, the following information should be provided by the purchaser:

1. The standard to be used—that is, ANSI/AWWA D100, Welded Carbon Steel Tanks for Water Storage, of latest revision.
2. Whether compliance with NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects, is required.
3. Capacity.
4. Bottom capacity level (BCL) or maximum operating level (MOL) above top of foundation.
5. Type of roof.
6. Head range, if specific range is required.
7. Diameter and type of riser.
8. Location of site.
9. Desired time for completion.
10. Name of, and distance to, nearest town.
11. Name of, and distance to, nearest railroad siding.
12. Type of road available for access to the site and whether it is public or private.
13. Availability of electric power; who furnishes it; at what fee, if any; what voltage; whether direct or alternating current; and, if alternating current, what cycle and phase.
14. Availability of compressed air, pressure, volume, and fee, if any.
15. Whether details of all welded joints are to be provided (Sec. 1.3).

16. Whether mill test reports are required (Sec. 2.1).
17. Details of other federal, state, local, and provincial requirements.
18. Type of pipe and fittings for fluid conductors (Sec. 2.2.11), including type of pipe joint if different from that permitted in Sec. 2.2.11.
19. The risk category for the structure (Sec. 3.1.1).
20. If the tank is located in an area designated CS in or at an elevation above the limits of ASCE 7, Figure 7-1, the ground snow load (Sec. 3.1.4.1).
21. If tank is located in a special wind region, the basic wind speed (Sec. 3.1.6.1.1).
22. Corrosion allowance, if any, to be added to parts that will be in contact with water and to parts that will not be in contact with water (Sec. 3.9).
23. Whether a balcony is required for inspection and painting when a horizontal girder is not required by the tank design (Sec. 4.4.4.2).
24. Location of manholes, ladders, and any additional accessories required (Sec. 5).
25. Number and location of pipe connections, and type and size of pipe to be accommodated.
26. Whether a safety grill at the top of the riser is required (Sec. 5.1.1).
27. Whether a removable silt stop is required (Sec. 5.2.1).
28. Overflow type, whether stub, to ground, or (if applicable) to extend below balcony; size of pipe; and pumping and discharge rates (Sec. 5.3).
29. Whether personal fall arrest systems, rest platforms, roof–ladder guardrails, or other safety devices are required and on which ladders, and whether requirements in excess of OSHA[§] CFR Part 1910 are required (Sec. 5.4). NOTE: Purchaser is to specify beginning location of outside tank ladder if other than at a level of 10 ft (3.0 m) above grade (Sec. 5.4.2.2).
30. Whether a special pressure-vacuum-screened vent or a pressure-vacuum relief mechanism is required for the tank vent (Sec. 5.5.2).
31. Requirements for any additional accessories required, including provisions for antennas and related equipment (Sec. 5.6).
32. Whether welding procedure specifications are to be provided (Sec. 8.2.1.5).
33. For butt-joint welds subject to secondary stress, whether complete joint penetration is to be provided at joints in base metals of thicknesses greater than $\frac{3}{8}$ in. (9.5 mm) (Sec. 8.4.2 (2)).
34. Whether seal welding is required and, if so, where it is required (Sec. 8.14.2).

[§] Occupational Safety and Health Administration, 200 Constitution Avenue N.W., Washington, DC 20210.

35. Whether the purchaser will provide shop inspection.
36. Whether a written report is required certifying that the work was inspected as set forth in Sec. 11.2.
37. Whether radiographic film and inspection reports must be provided (Sec. 11.2).
38. Kinds of paint or protective coatings and number of coats for inside and outside surfaces (see ANSI/AWWA D102, Coating Steel Water-Storage Tanks).
39. Soil investigation (Sec. 12.2.1), including foundation design criteria, type of foundation, depth of foundation below existing grade, Site Class for seismic areas, and design soil-bearing pressure, including factor of safety (Sec. 12.3). NOTE: Unless otherwise specified, the top of foundation(s) shall be a minimum of 6 in. (152 mm) above finish grade (Sec. 12.7.1).
40. Pile type and depth below existing grade when a pile-supported foundation is required (Sec. 12.7.3) and provisions for establishing criteria for compensation adjustment due to piling length changes resulting from varying subsurface conditions.
41. Whether the effect of buoyancy is to be considered in the foundation design (Sec. 12.7.4).
42. Whether requirements of ACI 301, Specifications for Structural Concrete, are applicable to the concrete work (Sec. 12.8).
43. Vertical distance from finished ground level to the crown of inlet and outlet pipe (earth cover) at riser pier (Sec. 12.9.2), if different from Figure 3.
44. Whether the site-specific procedure of Sec. 13.2.7 is required.
45. Whether third-party inspection will be used by the purchaser and for which items.

III.A.2. Information to Be Provided by Purchaser for a Standpipe or Reservoir (Ground-Supported Flat-Bottom Tanks). This standard provides minimum requirements for the design, construction, inspection, and testing of the tank without any designation of which party must perform these tasks. For this reason, the following items should be provided by the purchaser:

1. The standard to be used—that is, ANSI/AWWA D100, Welded Carbon Steel Tanks for Water Storage, of latest revision.
2. Whether compliance with NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects, is required.
3. Capacity.
4. Maximum operating level (MOL) above top of foundation.
5. Type of roof.

6. Location of site.
7. Desired time for completion.
8. Name of, and distance to, nearest town.
9. Name of, and distance to, nearest railroad siding.
10. Type of road available for access to the site and whether it is public or private.
11. Availability of electric power; who furnishes it; at what fee, if any; what voltage; whether direct or alternating current; and, if alternating current, what cycle and phase.
12. Availability of compressed air, pressure, volume, and fee, if any.
13. Whether details of all welded joints are to be provided (Sec. 1.3).
14. Whether mill test reports are required (Sec. 2.1).
15. Details of other federal, state or provincial, and local requirements.
16. Type of pipe and fittings for fluid conductors (Sec. 2.2.11), including type of pipe joint if different from that permitted in Sec. 2.2.11.
17. The risk category for the structure (Sec. 3.1.1).
18. If the tank is located in an area designated CS in or at an elevation above the limits of ASCE 7, Figure 7-1, the ground snow load (Sec. 3.1.4.1).
19. If tank is located in a special wind region, the basic wind velocity (Sec. 3.1.6.1.1).
20. Corrosion allowance, if any, to be added to parts that will be in contact with water and to parts that will not be in contact with water (Sec. 3.9). This also applies when a tank is to comply with Sec. 14.
21. Size and quantity of flush-type cleanouts, if required (Sec. 3.13.2.5).
22. Location of manholes, ladders, and additional accessories required (Sec. 7).
23. Number and location of pipe connections, and type and size of pipe to be accommodated.
24. The bottom capacity level (BCL) of the tank, when empty, if it differs from the level when the tank would be emptied through the specified discharge fittings (Sec. 7.2).
25. Whether a removable silt stop is required (Sec. 7.2.1).
26. Overflow type, whether stub or to ground; size of pipe; and pumping and discharge rates (Sec. 7.3).
27. Whether personal fall arrest systems, rest platforms, roof–ladder guardrails, or other safety devices are required and on which ladders, and whether requirements in excess of OSHA CFR Part 1910 are required (Sec. 7.4). NOTE: Purchaser is to specify

beginning location of outside tank ladder if other than at a level of 10 ft (3.0 m) above the level of the tank bottom (Sec. 7.4.2.2).

28. Whether a special pressure-vacuum-screened vent or a pressure-vacuum relief mechanism is required for the tank vent (Sec. 7.5.2).

29. Requirements for any additional accessories required, including provisions for antennas and related equipment (Sec. 7.6).

30. Whether welding procedure specifications are to be furnished (Sec. 8.2.1.5).

31. For butt-joint welds subject to secondary stress, whether complete joint penetration is to be provided at joints in materials of thicknesses greater than $\frac{3}{8}$ in. (9.5 mm) (Sec. 8.4.2 (2)). NOTE: For tanks that are to comply with Sec. 14, complete joint penetration is required for all butt-welded shell joints.

32. Whether seal welding is required and, if so, where it is required (Sec. 8.14.2).

33. Whether the purchaser will provide shop inspection.

34. Whether a written report is required certifying that the work was inspected as set forth in Sec. 11.2.

35. Whether radiographic film and inspection reports must be provided (Sec. 11.2).

36. Kinds of paint or protective coatings and number of coats required for inside and outside surfaces except underside of bottom (see ANSI/AWWA D102, Coating Steel Water Storage Tanks).

37. Soil investigation (Sec. 12.2.1), including foundation design criteria, type of foundation (Sec. 12.6), depth of foundation below existing grade, Site Class for seismic areas, and design soil-bearing pressure, including factor of safety (Sec. 12.3). NOTE: Unless otherwise specified, the top of the foundation is to be a minimum of 6 in. (152 mm) above the finish grade (Sec. 12.7.1).

38. Pile type and depth below existing grade when a pile-supported foundation is required (Sec. 12.7.3). The provisions for establishing criteria for compensation adjustment due to piling length changes resulting from varying subsurface conditions.

39. Whether the effect of buoyancy is to be considered in the foundation design (Sec. 12.7.4).

40. Whether requirements of ACI 301, Specifications for Structural Concrete, are applicable to the concrete work (Sec. 12.8).

41. Vertical distance from finished ground level to the crown of inlet and outlet pipes (earth cover) at tank foundation (Sec. 12.9.2), if different from Figure 3.

42. Whether the site-specific procedure of Sec. 13.2.7 is required.

43. Whether seismic design of roof framing and columns is required (Sec. 13.5.4.4) and amount of live loads to be used.

44. Whether design in accordance with Sec. 14 is allowed or required (Sec. 14.1.1). For tanks designed under Sec. 14, specify the design metal temperature (Sec. 14.2.4).

45. Whether a certified welding inspector is required for Sec. 14 tanks (Sec. 14.4.5).

46. Whether third-party inspection will be used by the purchaser and for which items.

III.B. *Information to Be Provided with Bid.*

III.B.1. Information to Be Provided with the Bid for an Elevated Tank. The following information should be provided by the bidder for an elevated tank:

1. A drawing showing the dimensions of the tank and tower, including the tank diameter, the height to BCL and MOL, sizes of principal members, and thickness of plates in all parts of the tank and tower. Also, the maximum wind or seismic gross moment and shear on the foundation system should be identified.

2. The number, names, and sizes of all accessories.

3. Painting information, if included.

III.B.2. Information to Be Provided with the Bid for a Standpipe or Reservoir (Ground-Supported Flat-Bottom Tanks). The following information shall be provided for a ground-supported flat-bottom tank:

1. A drawing of the standpipe or reservoir showing

a. design basis (i.e., whether Sec. 14 is used);

b. diameter, height to the MOL, and shell height;

c. shell plate widths, thicknesses, and grades;

d. roof type, thickness, and the type, size, and configuration of roof support structure (if any);

e. bottom thickness;

f. thickness, width, and grade of butt-welded annulus (if any); and

g. type, size, and quantity of mechanical anchors (if any).

2. The number, names, and sizes of all accessories.

3. Painting information, if included.

III.C. *Modification to Standard.* Any modification of the provisions, definitions, or terminology in this standard must be provided in the contract documents.

IV. Major Revisions. This edition of the standard includes numerous corrections, updates, and new material to clarify some of the existing requirements.

1. Sec. 1 was revised to show the latest edition of references.
2. Sec. 2 was revised to eliminate obsolete material references (i.e., ASTM A283/A283M, grades A and B).
3. Sec. 3 was revised to include risk category definitions from ASCE 7-16. Snow and wind loads were revised to comply with ASCE 7-16. The basic wind speed map was deleted, and a reference to the basic wind speed map in ASCE 7-16 was added. Material class 0 and related unit stresses were deleted. Method 1 for determining the allowable local buckling compressive stress, F_L , for shells was revised to use the requirements of reference 11 in Sec. A.1.4, Method 2 was deleted, and Method 3 was renamed Method 2. Ladder, handrail and guardrail loads were removed, and references to OSHA and ASCE 7 were added. Additional rules for shell girders and roof knuckles were added. Design requirements for anchorages were clarified.
4. Sec. 12 was revised to update the safety factors for deep and shallow foundations based on the level of testing employed.
5. Sec. 13 was revised so that seismic load complies with ASCE 7-16. The site classification procedure was deleted, and a reference to the procedure in ASCE 7-16 was added. Spectral response acceleration maps and the long-period transition period map were deleted, and references to the maps in ASCE 7-16 were added. The vertical design acceleration was revised to include values for responses limited by buckling and responses not limited by buckling. Minimum freeboard requirements were made mandatory of all styles of tanks. The sloshing wave height equation was revised to match ASCE 7-16. The equation for allowable lateral shear for flat-bottom tanks was revised to show a service-level allowable similar to API 650 and ASCE 7-16.
6. Sec. 14 was revised to eliminate references to withdrawn material specifications (i.e., ASTM A442 and A678).

V. Comments. If you have any comments or questions about this standard, please call AWWA Engineering and Technical Services group 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.



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ANSI/AWWA D100-21
(Revision of ANSI/AWWA D100-11)

AWWA Standard

Welded Carbon Steel Tanks for Water Storage

SECTION 1: GENERAL

Sec. 1.1 Scope

The purpose of this standard is to provide minimum requirements for the design, construction, inspection, and testing of new welded carbon steel tanks for the storage of water at atmospheric pressure.

1.1.1 *Tank roofs.* All tanks storing potable water shall have roofs. Tanks storing nonpotable water may be constructed without roofs.

1.1.2 *Items not covered.* This standard does not cover all details of design and construction because of the large variety of sizes and shapes of tanks. Details that are not addressed shall be designed and constructed to be adequate and as safe as those that would otherwise be provided under this standard. This standard does not address composite elevated tanks (i.e., steel tanks with a concrete support structure) (see ANSI/AWWA D107, Composite Elevated Tanks for Water Storage). With the exception of aluminum dome roofs, this standard does not cover tanks constructed with materials other than carbon steel. This standard does not cover painting and disinfecting of tanks (see ANSI/AWWA D102, Coating Steel Water-Storage Tanks, and ANSI/AWWA C652, Disinfection of Water-Storage Facilities).

1.1.3 *Design method.* With the exception of reinforced concrete foundations, this standard is based on the allowable-stress design method.