

# Steel Water-Storage Tanks

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**AWWA MANUAL M42**

*Revised Edition*



**American Water Works  
Association**



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# Contents

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**List of Figures, vii**

**List of Tables, xi**

**Preface, xiii**

**Acknowledgments, xv**

**Introduction, xvii**

- Definitions, xviii
- AWWA Standards, xviii
- Welded Tanks, xix
- Bolted Tanks, xx
- Composite Elevated Tanks, xx

**Part I Elements of Steel Water Tanks 1**

**Chapter 1 Typical Capacities and Configurations. ....3**

- Reservoirs, 3
- Standpipes, 3
- Roof Designs for Reservoirs and Standpipes, 10
- Elevated Tanks, 12
- Multiple-Column Elevated Tanks, 13
- Pedestal Elevated Tanks, 18

**Chapter 2 Appurtenances.....29**

- Shell Manholes, 29
- Pipe Connections, 30
- Overflow, 32
- Ladders and Safety Devices, 33
- Roof Openings, 36
- Vents, 37
- Devices for Indicating Water Level, 39
- Emergency Fill/Withdraw Connections, 40

**Chapter 3 Cathodic Protection. ....41**

- Nature of Corrosion, 41
- Principles of Cathodic Protection, 43
- Cathodic Protection Design, 44
- Maintenance, 45

**Chapter 4 Coating Systems .....49**

- Interior Coatings, 49
- Exterior Coatings, 51
- Inspection and Quality Control, 52
- Removing Coating by Abrasive Blasting, 52

<b>Part II</b>	<b>The New Tank Project</b>	<b>55</b>
<b>Chapter 5</b>	<b>Selecting and Sizing Water-Storage Tanks.....</b>	<b>57</b>
	Peak Demand, 57	
	Fire Flow, 58	
	Top and Bottom Capacity Levels, 58	
	Water Quality Issues, 58	
	Energy Costs, 60	
	Future Needs, 60	
	Environmental Impact, 60	
	Tank Costs, 60	
<b>Chapter 6</b>	<b>Construction Considerations .....</b>	<b>63</b>
	Design Standards, 63	
	Contract Documents, 64	
	Constructor Capabilities, 64	
	Guarantees, 64	
	Soil Investigations, 64	
	Reservoir and Standpipe Foundations, 67	
	Elevated Tank Foundations, 69	
	Tank Site, 69	
	Tank Coating: Welded Steel Tanks, 71	
	Tank Coating: Bolted Steel Tanks, 73	
	Tank Water Testing and Disinfection, 73	
	Engineer's Role, 73	
	Bidding Documents, 74	
<b>Chapter 7</b>	<b>Inspecting New Tank Construction. ....</b>	<b>77</b>
	Responsibility for Quality, 77	
	The Foundation, 78	
	Fabrication, 80	
	Steel Delivery, 80	
	Tank Erection, 80	
	Field Cleaning and Coating, 83	
	Mechanical and Electrical Appurtenances, 85	
<b>Part III</b>	<b>Existing Tanks</b>	<b>87</b>
<b>Chapter 8</b>	<b>Routine Operation and Maintenance.....</b>	<b>89</b>
	Energy Management, 89	
	Controls, 90	
	Periodic Operator Inspection, 90	
	Tank Washouts, 92	
<b>Chapter 9</b>	<b>Professional Examination and Renovation .....</b>	<b>95</b>
	Tank Maintenance Engineer's Functions and Qualifications, 96	
	Pre-Bid Inspection, 98	
	Preparing Specifications, 103	
	Monitoring the Constructor's Progress, 105	
	Periodic Reinspection, 108	

<b>Chapter 10</b>	<b>Cold-Weather Operation.....</b>	<b>109</b>
	Causes and Results of Freezing, 109	
	Data Related to Freezing, 112	
	Designing Tanks for Cold Weather, 112	
	Cold-Weather Operating Procedures, 117	
	Systems to Prevent Freezing, 119	
	Dealing With Frozen Tanks, 121	
<b>Appendix A</b>	<b>Bibliography .....</b>	<b>123</b>
<b>Appendix B</b>	<b>Steel Water Tank Industry Standards .....</b>	<b>125</b>
<b>Appendix C</b>	<b>ANSI/AWWA D101-53 (R86), Inspecting and Repairing Steel Water Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage .....</b>	<b>131</b>
<b>Index</b>	<b>141</b>	
<b>AWWA List of Manuals</b>	<b>147</b>	

# Introduction

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More than 100,000 steel water-storage tanks have been constructed within the last 100 years, a value that far exceeds the number of large water-storage vessels of any other type of construction material. Many steel water tanks have service histories in excess of a century and are still in service today (Figure F-1). Whereas early tanks were riveted, modern practice uses welded or bolted design and construction, which provide the advantage of a zero leakage tolerance.

To further increase their potential service life, steel tanks can be dismantled and re-erected in new locations. A tank that was originally in an optimal location can become useless if a factory relocates or there is a shift in housing patterns. However, a steel tank can be dismantled and then erected and coated at a new location.

This manual provides information on the selection, design, construction, maintenance, inspection, and repair of steel tanks for potable water storage. The manual will assist in tank sizing, configuration, site selection, design, operation, and maintenance.



*Source:* Tank Industry Consultants Inc.

Figure F-1 A tank constructed in 1902 is still serving Wabash, Ind., with practically no metal loss

## DEFINITIONS

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The following definitions apply in this manual:

**Bottom capacity level (BCL)** The water level in the tank when the tank is emptied through the specified discharge fittings (unless otherwise specified by the purchaser). In an elevated tank, the elevation of the bottom capacity level(s) is as given by the purchaser and is determined by the design features of the tank configuration.

**Capacity** The net volume in gallons (liters) that may be removed from a tank emptied to its bottom capacity level after being filled to its top capacity level.

**Constructor** The party that furnishes the work and materials for placement and installation.

**Elevated tank** A container or storage tank supported on one or more columns.

**Engineer** An employee of the purchaser or, more commonly, a professional engineering firm engaged by the purchaser to perform specification and inspection services.

**Head range** The difference between the lower and upper capacity levels of a tank.

**Manufacturer** The person or company that furnishes the tank components.

**Owner** The person or firm that will own and operate the completed tank. The owner may designate agents, such as an engineer, purchaser, or inspector, for specific project responsibilities.

**Purchaser** The person, company, or organization that purchases the tank.

**Reservoir** A ground-supported, flat-bottom cylindrical tank with a shell height less than or equal to its diameter.

**Standpipe** A ground-supported, flat-bottom cylindrical tank with a shell height greater than its diameter.

**Tank** An elevated tank, standpipe, or reservoir used for water storage.

**Top capacity level (TCL)** The maximum operating level of water in a tank, as dictated by the elevation at which water discharges from the tank through the overflow pipe entrance. In a standpipe or reservoir, the top capacity level is as given by the purchaser. In an elevated tank, the elevation of the top and/or bottom capacity level(s) is as given by the purchaser.

## AWWA STANDARDS

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The majority of all steel potable water-storage tanks constructed in the United States adhere to specifications that reference the following American Water Works Association (AWWA) steel tank standards:

- ANSI/AWWA D100, Standard for Welded Carbon Steel Tanks for Water Storage.
- ANSI/AWWA D102, Standard for Coating Steel Water-Storage Tanks.
- ANSI/AWWA D103, Standard for Factory-Coated Bolted Carbon Steel Tanks for Water Storage.
- ANSI/AWWA D104, Standard for Automatically Controlled, Impressed-Current Cathodic Protection for the Interior Submerged Surfaces of Steel Water Storage Tanks.
- ANSI/AWWA D106, Standard for Sacrificial Anode Cathodic Protection Systems for the Interior Submerged Surfaces of Steel Water Storage Tanks.

- ANSI/AWWA D107, Standard for Composite Elevated Tanks for Water Storage.
- ANSI/AWWA D108, Standard for Aluminum Dome Roofs for Water Storage Facilities.
- ANSI/AWWA C652, Standard for Disinfection of Water-Storage Facilities.

These standards (except ANSI/AWWA C652) are developed and maintained under the direction of the AWWA Standards Committee on Steel Elevated Tanks, Standpipes, and Reservoirs, which is composed of members representing consumer (utility), general interest (academic and consulting engineering), and producer (constructor and manufacturer) groups. ANSI/AWWA C652 was developed and is maintained by the AWWA Standards Committee on Disinfection of Facilities.

Once a draft standard or revision is approved by a standards committee, it is forwarded to the AWWA Standards Council for review and approval. If approved by the council, it is offered for public review and then presented to the AWWA Board of Directors for final approval. The standards listed above have also been approved as standards by the American National Standards Institute (ANSI). AWWA D101-53 (R86), Standard for Inspecting and Repairing Steel Water Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage (included here as appendix C), was withdrawn upon publication of the first edition of this manual in 1998.

## WELDED TANKS

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Welded tanks have been used for water storage since the 1930s. Welded construction had totally replaced riveted construction by the 1950s. This 20-year transition period from riveted to welded design and construction was necessary because time was needed to train enough skilled welders and because contractors wanted to keep their skilled riveting crews working as long as possible. Today, design and construction of welded tanks are usually performed under the guidelines of ANSI/AWWA D100. This standard was first published in the November 1935 edition of *Journal - American Water Works Association* as “Standard Specifications for Riveted Steel Tanks and Standpipes” and has undergone several revisions since then.

### Advantages

The advent of welded tanks provided opportunities for new tank configurations, but the greatest advantage of welded over riveted tanks was the development of smooth structures with much lower maintenance costs than was possible with lapped, riveted seams. Manual, semiautomatic, and automatic welding processes have improved continually over the years, offering increased economy and strength.

### Thicknesses and Capacities

Thicknesses of welded tank shells vary from  $\frac{3}{16}$  in. (4.76 mm) to 2 in. (50 mm) or more. As of the writing of this manual, the largest welded steel water-storage tank constructed had a capacity of 34 mil gal (130 ML). Elevated tanks have been constructed with capacities up to 4 mil gal (15 ML), and designs are available for greater capacities.

## BOLTED TANKS

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Factory-coated bolted steel storage tanks were developed in the early 1900s to serve as crude-oil and brine containment vessels. In the late 1970s, this tank design gained acceptance for potable water containment through the release of ANSI/AWWA D103, which allows the use of lighter-gauge steel in the production of tank sheets.

### Construction

Bolted steel tanks are made of uniformly sized panels (usually 5 ft wide by 8 ft high or 9 ft wide by 5 ft high [1.5 m × 2.4 m or 2.7 m × 1.5 m]), which can be readily transported and assembled at the tank site. Organic gaskets or sealants are used to achieve a watertight seal at the bolted joints. Thicknesses of bolted tank panels vary from a minimum of 0.073 in. (1.85 mm) to 0.500 in. (12.7 mm). Since the panels are bolted together, the tanks can be dismantled and relocated with relative ease.

### Capacities

Bolted tanks are currently offered in incremental sizes depending on the tank manufacturer's panel size. Capacities offered range from 4,000 gal (15,000 L) to approximately 2.5 mil gal (6.8 ML). Bolted tanks are available in reservoir and standpipe configurations. Maximum tank heights and capacities are limited by the manufacturer's steel fabrication facility, as well as by ANSI/AWWA D103.

### Coating and Life of Tank

Bolted tanks are factory coated for long-term corrosion protection. Four coating systems are presently available for bolted tanks: galvanized, glass, thermoset liquid suspension epoxy, and thermoset powder epoxy. According to the foreword of ANSI/AWWA D103, the anticipated life of a bolted tank is usually limited by the effective life of the protective coating and cathodic protection system. If the coatings are not abused or damaged, the anticipated life expectancy of bolted tanks is more than 30 years.

## COMPOSITE ELEVATED TANKS

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Composite elevated tanks have been used for water storage since the 1970s, with hundreds of tanks of this style having been constructed and placed into service before the issuance of an AWWA standard. Today the design and construction of composite elevated welded tanks are performed under the guidelines of ANSI/AWWA D107, which was issued in 2010.

NOTE: The scope of ANSI/AWWA D107 is specific to “composite elevated tanks that use a *welded* steel tank for watertight containment” (emphasis added). As of the publication of this edition of Manual M42, no national standard exists that provides guidance on the design, construction, inspection, and testing of composite elevated tanks that use a *bolted* steel tank for watertight containment.

### Construction

The composite elevated water tank consists of a concrete support structure (pedestal) and a welded or bolted steel tank. A variety of different styles of pedestal construction are employed by tank fabricators. The top of the pedestal may be constructed with either a concave, convex, or flat top. A welded steel liner is placed over the concrete pedestal top and serves as the floor of the welded steel tank. Bolted tanks may be furnished with a concrete or bolted steel floor.