M11

Steel Pipe—

A Guide for Design and Installation

American Water Works Association

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Fifth Edition

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American Water Works Association

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Steel Pipe—A Guide for Design and Installation

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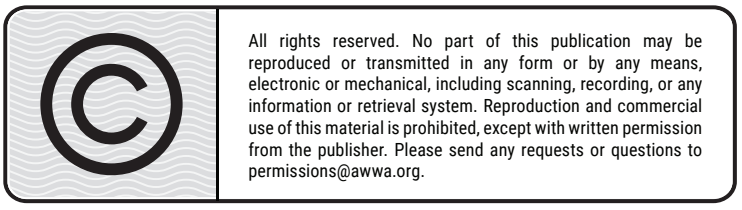

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Preface

This manual provides a review of experience and theory regarding design of steel pipe used for conveying water, with appropriate references cited. The manual provides general and technical information to be used as an aid in the design and installation of steel pipe. It is a discussion of recommended practice, not an AWWA standard calling for compliance with certain specifications. Application of the principles and procedures discussed in this manual must be based on responsible judgment.

This manual was first authorized in 1943. In 1949, Committee 8310D on Steel Pipe, appointed one of its members, Russell E. Barnard, to act as editor in chief in charge of collecting and compiling the available data on steel pipe. The first draft of the report was completed by January 1957; the draft was reviewed by the committee and other authorities on steel pipe. The first edition of this manual was issued in 1964 with the title *Steel Pipe—Design and Installation*.

The second edition of this manual was approved in June 1984 and published in 1985 with the title *Steel Pipe—A Guide for Design and Installation*. The third edition of the manual was approved in June 1988 and published in 1989. The fourth edition of the manual was approved March 2003 and published in January 2004. This fifth edition was approved August 2016.

Major revisions to this fifth edition are (1) reorganization of the chapters to combine similar content in the same chapters; (2) elimination of some tables which were replaced with formulas and examples; (3) changes in aboveground design and examples to more clearly reflect conditions encountered on a water pipeline; (4) addition of a chapter on thrust design; (5) addition to the fittings chapter to include design of true wyes and crosses, design of crotch plates with higher strength steel, expanded elbow stress design in restrained areas, tangential outlet design was clarified, double outlet design was clarified, strength reduction factors for varying steel strengths of outlets was added, PDV values were clarified to 9000 for test and transient pressures, anchor ring design was added, design of ellipsoidal heads was added, and modified joint harness requirements; (6) added suggested bracing for shipping of pipe; (6) updated the flange bolt torque values and table; (7) buckling of buried pipe was clarified (8) weld details for outlets and crotch plates were added; (9) cement enhanced soil was defined and added; (10) design of welded lap joints was expanded; and (11) Appendixes were added for nomenclature, comparison of increase of E' versus increase of wall thickness, full example of harness ring design, design of harness rod placement for differential settlement, seismic considerations, and useful equations and conversions.

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Acknowledgments

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Chapter 1

History, Uses, and Physical Characteristics of Steel Pipe

HISTORY

Steel pipe has been used for water lines in the United States since the early 1850s. The pipe was first manufactured by rolling steel sheets or plates into shape and riveting the seams. Recognized very early in its development as a significant benefit, steel pipe offered flexibility that allowed variations in the steel sheet thickness being rolled to handle the different pressures based on the pipe's elevation and the hydraulic gradient. Roll-formed pipe with riveted seams was the dominant method of pipe fabrication until the 1930s when the electric welding process replaced the labor-intensive riveted seams.

In consideration of the relatively low tensile strength of steels produced in the second half of the nineteenth century and the inefficiencies of cold-riveted seams and riveted or drive stovepipe joints, engineers set the allowable design stress at 10,000 psi. As riveted-pipe fabrication methods improved through the early part of the twentieth century, concurrently higher strength steels were being produced. As a result, allowable design stresses progressed in this period from 10,000 psi to 12,500 psi, to 13,750 psi, and finally to 15,000 psi, in all cases maintaining a safety factor of 4 to the steel's tensile strength. Allowable design stresses were adjusted as necessary to account for the inefficiency of the riveted seam. The pipe was produced in diameters ranging from 4 in. through 144 in. and in thicknesses from 16 gauge to 1.5 in. Fabrication methods consisted of single-, double-, triple-, and quadruple-riveted seams, varying in efficiency from 45 percent to 70 percent, depending on the design.

Lockbar pipe, introduced in 1905, had nearly supplanted riveted pipe by 1930. Fabrication involved milling 30-ft-long plates to a width approximately equal to half the intended circumference, cold forming the longitudinal edges, and rolling the plates into