ANSI/AWWA C106/A21.6–80

Revision of
ANSI A21.6–1975
(AWWA C106–75)

AMERICAN NATIONAL STANDARD

for

GRAY-IRON PIPE CENTRIFUGALLY CAST IN METAL MOLDS, FOR WATER OR OTHER LIQUIDS

ADMINISTRATIVE SECRETARIAT
AMERICAN WATER WORKS ASSOCIATION

CO-SECRETARIATS
AMERICAN GAS ASSOCIATION
NEW ENGLAND WATER WORKS ASSOCIATION

Made standard Jan. 13, 1953.
Revised edition approved by American National Standards Institute, Inc., May 9, 1980.

PUBLISHED BY

AMERICAN WATER WORKS ASSOCIATION
6666 West Quincy Avenue, Denver, Colorado 80235

AVA Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

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 he 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, promotion material, or on tags or labels that the goods are produced in conformity with particular American National Standards.

CAUTION NOTICE. This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffrm, revise, or withdraw this standard no later than five (5) 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, 1430 Broadway, New York, N.Y. 10018, (212) 868-1220.

© Copyright 1980 by American Water Works Association
Printed in US

AVA Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

Committee Personnel

Subcommittee 1, Pipe, which developed this standard, had the following personnel at that time:

EDWARD C. SEARS, *Chairman*
WALTER AMORY, *Vice-Chairman*

User Members	*Producer Members*
ROBERT S. BRYANT	W. D. GOODE
FRANK E. DOLSON	THOMAS D. HOLMES
LEE J. DOSEDLO	HAROLD KENNEDY, JR.
HARRY J. FORR	PHILIP I. MCGRATH, JR.
GEORGE F. KEENAN	JOSEPH H. MILLER
W. HARRY SMITH	TROY F. STROUD
	THURMAN UPCHURCH

Standards Committee A21, Cast-Iron Pipe and Fittings, which reviewed and approved this standard, had the following personnel at the time of approval:

ARNOLD M. TINKEY, *Chairman*
THOMAS D. HOLMES, *Vice-Chairman*
RICH BOGDANOVICH,* *Secretary*

Organization Represented	*Name of Representative*
American Gas Association	HARRY J. FORR
American Society of Civil Engineers	KENNETH W. HENDERSON
	DOUGLAS T. SOVERN †
American Society of Mechanical Engineers	JAMES S. VANICK
American Society for Testing & Materials	BEN HELTON *
	JOSEPH J. PALMER *
American Water Works Association	GERALD S. ALLEN
	ROBERT A. ARTHUR
	DONALD R. BOYD
	JOHN PORTER HENNINGS
	RAYMOND J. KOCOL
	ROBERT L. LEE
	W. HARRY SMITH
	ARNOLD M. TINKEY
	DAVID L. TIPPIN
	LLOYD W. WELLER

(*continued on next page*)

* Non-voting member
† Alternate

AVA Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

Committee Personnel (continued)

Organization Represented	*Name of Representative*
Canadian Standards Association	W. F. Semenchuk *
Ductile Iron Pipe Research Association	Thomas D. Holmes
	Philip I. McGrath, Jr.
	L. L. Neeper
	Edward C. Sears
	Troy F. Stroud
Individual Producers	William D. Goode
	Thurman Upchurch
Manufacturers' Standardization Society of the Valve & Fittings Industry	Harold Kennedy, Jr.
Naval Facilities Engineering Command	Stanley C. Baker
New England Water Works Association	Walter Amory
	Albert Helt †
Underwriters' Laboratories, Inc.	W. Cary †
	Lee J. Dosedlo

* Non-voting member
† Alternate

AVA Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

Table of Contents

SEC. PAGE

Foreword

I History of Standard vi
II Major Changes vii
III Acceptance Tests vii
IV Options viii

Standard

6–1 Scope 1
6–2 Definitions 1
6–3 General Requirements 1
6–4 Inspection and Certification by Manufacturer 2
6–5 Inspection by Purchaser 2
6–6 Delivery and Acceptance 2
6–7 Tolerances or Permitted Variations 2
6–8 Coatings and Linings 3
6–9 Hydrostatic Test 3
6–10 Marking Pipe 3
6–11 Weighing Pipe 3
6–12 Acceptance Tests 3
6–13 Ring Tests and Full-Length Bursting Tests 5
6–14 Chemical Analyses 6
6–15 Foundry Records 7
6–16 Additional Test Required by Purchaser 7
6–17 Defective Specimens and Retests .. 7
6–18 Rejection of Pipe 7
6–19 Determining Rejection 7

Appendix

Metric Tables 18

SEC. PAGE

Tables

Table 6.1 Selection Table for Push-On Joint Gray-Iron Pipe 8
Table 6.2 Selection Table for Mechanical-Joint Gray-Iron Pipe 10
Table 6.3 Standard Thickness Selection Table for Gray-Iron Pipe .. 12
Table 6.4 Standard Dimensions and Weights of Push-On Joint Gray-Iron Pipe 14
Table 6.5 Standard Dimensions and Weights of Mechanical-Joint Gray-Iron Pipe 16
Table 6.1M Selection Table for Push-On Joint Gray-Iron Pipe, Metric Dimensions 19
Table 6.2M Selection Table for Mechanical-Joint Gray-Iron Pipe, Metric 22
Table 6.3M Standard Thickness Selection Table for Gray-Iron Pipe, Metric 24
Table 6.4M Standard Dimensions and Masses of Push-On Joint Gray-Iron Pipe, Metric 26
Table 6.5M Standard Dimensions and Masses of Mechanical-Joint Gray-Iron Pipe, Metric 28

Figures

Fig. 6.1 Position From Which Talbot Strip is Cut 4
Fig. 6.2 Location of Rockwell Hardness Tests on Talbot Strip Specimen 5
Fig. 6.3 Assembly for Ring Test 5

Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

Foreword

This foreword is for information only and is not a part of ANSI/AWWA C106/A21.6.

I History of Standard

On Sep. 10, 1902, NEWWA adopted a "Standard Specification for Cast-Iron Pipe and Special Castings," covering bell-and-spigot pit-cast pipe and fittings of ten thickness classes. The thickness classes were based on allowable internal pressures varying by increments of 50 ft of head.

On May 12, 1908, AWWA adopted a "Standard Specification for Cast-Iron Pipe and Special Castings," covering bell-and-spigot pit-cast pipe and fittings of eight classes, A through H, with allowable working pressures varying by increments of 100 ft of head from 100 to 800 ft. Dimensions and weights were given for pipe and fittings.

In 1926, ASA Sectional Committee (now American National Standards Committee) A21 on Cast-Iron Pipe and Fittings was organized under the sponsorship of A.G.A., ASTM, AWWA, and NEWWA and was assigned the following scope:

> Unification of specifications for cast-iron pipe, including materials; dimensions; pressure ratings; methods of manufacture (including such new developments as centrifugal casting) insofar as they may be necessary to secure satisfactory specifications; elimination of unnecessary sizes and varieties; consideration of the possibility of developing a coordinated scheme of metallic pipe and fittings applicable to all common mediums; and methods of making up joints insofar as they are determining as to the dimensional design of cast-iron pipe.
>
> The types of cast-iron pipe [are] to include bell-and-spigot pipe, flanged pipe, flanged and bell mouth fittings and wall castings, pipe elbows, tees, wyes, return bends, and other fittings not now included in standard lists; cast-iron pipe threaded for flanges or couplings. The standardization is not to include methods of installing pipe and similar matters, except as to the making up of joints in its relationship to the dimensional standardization of pipe and fittings, as noted above.

Sectional Committee A21 sponsored many tests of pipe and fittings; these included subjection of pipe to combined earth load and internal pressures (which form the basis of pipe thickness design), corrosion tests, measurement of hydraulic friction loss in fittings, and tests of bursting strengths of pipe and fittings. After exhaustive study of the test results and other research, the committee in 1939 issued A21.1, "American Standard Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe." The manual included nomograms and thickness tables for pit-cast pipe with 11/31 * iron strength. As stated in the preface to that manual, however, the design method was applicable to pipe of any iron strength.

Discussions and interpretations of the method of design of cast-iron pipe were published in 1939 and presented to AWWA and A.G.A. As a result of these publications and because of the general acceptance of A21.1, a substantial volume of cast-iron pipe was designed by the new method and furnished to manufacturers' standards between 1939 and 1953. A standard (A21.2) for pit-cast pipe with 11/31 iron strength also was issued in 1939. Work on standards for centrifugally cast pipe with 18/40 iron strength was started after the design was completed

* The first figure designates the bursting tensile strength in units of 1000 psi and the second figure designates the ring modulus of rupture in units of 1000 psi.

Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

in 1939, but, owing to the intervention of World War II and other causes, they were not formally issued until 1953.

In 1957, a revision of A21.1 was issued. In that revision, designated ASA A21.1–1957 (AWWA H1–57) the major change was the addition of a method for computing earth loads on pipe laid under embankments and of nomograms and thickness tables for centrifugally cast pipe with 18/40 iron strength.

In 1958, Sectional Committee A21 was reorganized. Subcommittees were established to study each group of standards in accordance with the review and revision policy of ASA (now ANSI). The subcommittee on pipe (Subcommittee No. 1) was organized with the following assignment:

> The scope of the committee activity shall include an examination of all present A21 standards for pipe to determine what is needed to bring these up to date. The examination shall include A21.1, A21.2, A21.3, A21.6, A21.7, A21.8, and A21.9, as well as any other matters pertaining to pipe standards.

As a result of the work of Subcommittee No. 1 on this assignment, revisions of the cast-iron pipe standards A21.6 (AWWA C106), A21.7, A21.8 (AWWA C108) and A21.9 were issued in 1962. A revision of A21.1–1957 (AWWA H1–57) was issued in 1967 and reaffirmed without revision in 1972. Revisions of the 1962 cast-iron pipe standards were issued in 1970. The major revisions of A21.6–1970 were: pipe with push-on joints were added; laying conditions C and D were deleted and condition F was added; and, the tables were revised to include the pipe lengths then being produced.

In 1974, Subcommittee 1 reviewed the 1970 edition and recommended minor editorial changes. Therefore, the 1975 edition was unchanged from the 1970 edition except for minor editorial changes and the updating of the Foreword.

In 1979, Subcommittee 1 reviewed the 1975 standard and recommended the changes shown in Sec. II Major Changes below.

The tables and strength test requirements in this standard are for pipe with 18/40 iron strength. Advances in production technology have enabled the manufacturers to furnish pipe with greater strength. Pipe with 21/45 iron strength has been furnished for many years. Design details and standard thicknesses for pipe with 21/45 iron strength are shown in A21.1–1957 (AWWA C101–67), reaffirmed in 1972.

II Major Changes

1. Metric conversion. Metric conversions of all dimensions and physical requirements are included in this standard. Metric conversions of Tables 6.1–6.5 are shown in the Appendix. Metric dimensions are direct conversions of customary US inch–pound units and are not those specified in International Standards Organization (ISO) standards.

2. The bell and spigot joint (caulk joint) has been deleted.

3. Modification of the formulas for Talbot strip modulus of rupture and modulus of elasticity to make them dimensionally consistent and compatible with metric as well as inch–pound units.

III Acceptance Tests

Acceptance tests were established as routine control measures to ensure the design burst and ring strengths. The

AVA Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

acceptance tests specified in this standard are the Talbot strip test and the hardness test. In establishing the acceptance values for the Talbot strip test, A21 Committee in the 1940s reviewed detailed data, including burst, ring, and Talbot strip tests on more than 400 pipe centrifugally cast in metal molds. Correlations of the data showed that the Talbot strip modulus of rupture and secant modulus of elasticity values specified in this standard represent acceptable pipe which meet the design burst and ring strengths.

The hardness test was specified as a means of assuring the ferritic matrix which is characteristic of the microstructure of pipe cast in metal molds. The specified acceptance values for the Talbot strip test provide additional control of the microstructure to ensure satisfactory machinability.

IV Options

This standard includes certain options which, if desired, must be specified in the invitation for bids and on the purchase order. Also, a number of items must be specified to describe completely the pipe required. The following summarizes these details and available options and lists the sections of the standard where they can be found.

1. Size, joint type, thickness or class, and laying lengths (Tables).
2. Special joints (Sec. 6–1).
3. Certification by manufacturer (Sec. 6–4).
4. Inspection by purchaser (Sec. 6–5).
5. Cement lining (Sec. 6–8.2). Experience has indicated that asphaltic inside coating is not complete protection against loss in pipe capacity caused by tuberculation. Cement linings are recommended for most waters.
6. Special coatings and linings (Sec. 6–8.4).
7. Special marking on pipe (Sec. 6–10).
8. Written transcripts of foundry records (Sec. 6–15).
9. Special tests (Sec. 6–16).

AVA Documents
Document Sharing Hub
Full document details: ANSI AWWA C106 - A21.6-80 scan

Revision of
ANSI A21.6–1975
(AWWA C106–75)

American National Standard for

Gray-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids

Sec. 6–1 Scope

This standard covers 3-in. through 24-in. gray-iron pipe centrifugally cast in metal molds for water or other liquids. Characteristics of such pipe with push-on joints, and mechanical joints are given in the tables. This standard may be used for pipe with such other types of joints as may be agreed upon at the time of purchase. The thicknesses, weights, and strength test requirements shown in this standard are for pipe with 18/40 iron strength 18 000 psi (124.1MPa) minimum bursting tensile and 40 000 psi (275.8 MPa) minimum ring modulus of rupture).

Sec. 6–2 Definitions

Under this standard, the following definitions shall apply:

6–2.1. *Purchaser.* The party entering into a contract or agreement to purchase pipe according to this standard.

6–2.2. *Manufacturer.* The party that produces the pipe.

6–2.3. *Inspector.* The representative of the purchaser, authorized to inspect in behalf of the purchaser to determine whether or not the pipe meet this standard.

6–2.4. *Gray iron.* The unqualified term gray iron shall apply to gray cast-iron which is a cast ferrous material in which a major part of the carbon content occurs as free carbon in the form of flakes interspersed through the metal.

6–2.5. *Push-on joint.* The single rubber-gasket joint as described in ANSI/AWWA C111/A21.11 of latest revision.

6–2.6. *Mechanical joint.* The gasketed and bolted joint as detailed in ANSI/AWWA C111/A21.11 of latest revision.

Sec. 6–3 General Requirements

6–3.1. Pipe with push-on joints, and mechanical joints shall conform to the applicable dimensions and weights shown in the tables in this standard and to the applicable requirements of ANSI/AWWA C111/A21.11 of latest revision. Pipe with other types of joints shall comply with the joint dimensions and weights agreed upon at the time of purchase, but in all other respects shall fulfill the requirements of this standard.

6–3.2. The nominal laying length of the pipe shall be as shown in the tables. A maximum of 10 percent of the total

AVA Documents
Document Sharing Hub

Full document details: ANSI AWWA C106 - A21.6-80 scan

number of pipe of each size specified in an order may be furnished by as much as 24 in. (610 mm) shorter than the nominal laying length, and an additional 10 percent may be furnished by as much as 3 in. (76 mm) shorter than nominal laying length.

Sec. 6–4 Inspection and Certification by Manufacturer

6–4.1. The manufacturer shall establish the necessary quality control and inspection practice to assure compliance with this standard.

6–4.2. The manufacturer shall, if required on the purchase order, furnish a sworn statement that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of this standard.

6–4.3. All pipe shall be clean and sound without defects which will impair their service. Repairing of defects by welding or other method shall not be allowed if such repairs will adversely affect the serviceability of the pipe or its capability to meet strength requirements of this standard.

Sec. 6–5 Inspection by Purchaser

6–5.1. If the purchaser desires to inspect pipe at the manufacturer's plant, the purchaser shall so specify on the purchase order, stating the conditions (such as time, and the extent of inspection) under which the inspection shall be made.

6–5.2. The inspector shall have free access to those parts of the manufacturer's plant that are necessary to assure compliance with this standard. The manufacturer shall make available for the inspector's use such gages as are necessary for inspection. The manufacturer shall provide the inspector with assistance as necessary for the handling of pipe.

Sec. 6–6 Delivery and Acceptance

All pipe and accessories shall comply with this standard. Pipe and accessories not complying with this standard shall be replaced by the manufacturer at the agreed point of delivery. The manufacturer shall not be liable for shortages or damaged pipe after acceptance at the agreed point of delivery except as recorded on the delivery receipt or similar document by the carrier's agent.

Sec. 6–7 Tolerances or Permitted Variations

6–7.1. *Dimensions.* The spigot end, bell, and socket of the pipe and the accessories shall be gaged with suitable gages at sufficiently frequent intervals to ensure that the dimensions comply with the requirements of this standard. The smallest inside diameter of the sockets and the outside of the spigot ends shall be tested with circular gages. Other socket dimensions shall be gaged as appropriate.

6–7.2. *Thickness.* Minus thickness tolerances of pipe and bell shall not exceed those shown below:

Pipe Size *in.*	Minus Tolerance *in.* (*mm*)
3–8	0.05 (1.3)
10–12	0.06 (1.5)
14–24	0.08 (2.0)

NOTE: An additional tolerance of 0.02 in. (0.5 mm) shall be permitted over areas not exceeding 8 in. (203 mm) in any direction.

6–7.3. *Weight.* The weight of any single pipe shall not be less than the tabulated weight by more than 5 percent for pipe sizes 12 in. or smaller in diameter, nor by more than 4 percent

Documents
Document Sharing Hub
Full document details: ANSI AWWA C106 - A21.6-80 scan

for pipe sizes larger than 12 in. in diameter.

Sec. 6–8 Coatings and Linings

6–8.1. *Outside coating.* The outside coating for use under normal condition shall be an asphaltic coating approximately 1 mil (25 μm) thick. The coating shall be applied to the outside of all pipe, unless otherwise specified. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun and shall be strongly adherent to the pipe.

6–8.2. *Cement-mortar linings.* Cement linings shall be in accordance with ANSI/AWWA C104/A21.4 of latest revision. If desired, cement linings shall be specified in the invitation for bids and on the purchase order.

6–8.3. *Inside coating.* Unless otherwise specified, the inside coating for pipe not cement lined shall be an asphaltic material as thick as practicable at least 1 mil (25 μm) and conforming to all appropriate requirements for seal coat in ANSI/AWWA C104/A21.4.

6–8.4. *Special coatings and linings.* For special conditions, other types of coatings and linings may be available. Such special coatings and linings shall be specified in the invitation for bids and on the purchase order.

Sec. 6–9 Hydrostatic Test

Each pipe shall be subjected to a hydrostatic test of not less than 500 psi (3.45MPa). This test may be made either before or after the outside coating and the inside coating have been applied, but shall be made before the application of cement lining or of a special lining.

The pipe shall be under the full test pressure for at least 10 s. Suitable controls and recording devices shall be provided so that the test pressure and duration may be adequately ascertained. Any pipe that leaks or does not withstand the test pressure shall be rejected.

In addition to the hydrostatic test before application of a cement lining or special lining, the pipe may be retested, at the manufacturer's option, after application of such lining.

Sec. 6–10 Marking Pipe

The weight, class or nominal thickness, and sampling period shall be shown on each pipe. The manufacturer's mark and the year in which the pipe was produced shall be cast or stamped on the pipe. When specified on the purchase order, initials not exceeding four in number shall be cast or stamped on the pipe. All required markings shall be clear and legible and all cast marks shall be on or near the bell. All letters and numerals on pipe sizes 8 in. and larger shall not be less than $\frac{1}{2}$ in. (12.7 mm) in height.

Sec. 6–11 Weighing Pipe

Each pipe shall be weighed before the application of any lining or coating other than the asphaltic coating and the weight shall be shown on the outside or inside of the bell or spigot end.

Sec. 6–12—Acceptance Tests

The standard acceptance tests for the physical characteristics of the pipe shall be as follows.

6–12.1. *Talbot strip tests.* Talbot strip tests shall be used to determine the acceptability of modulus of rupture and secant modulus of elasticity for pipe sizes 3–24 in.

6–12.1.1. *Sampling.* At least one sample shall be taken during each period of approximately 3 hr. The sample for the first period shall be taken

AVA Documents
Document Sharing Hub
Full document details: ANSI AWWA C106 - A21.6-80 scan

during the first hour, or if casting is direct from the melting unit, from the first ladle. Samples shall be taken so that each size of pipe continuously cast for 2 hr or longer and each source of iron continuously used for 2 hr or longer shall be fairly represented.

6–12.1.2. *Acceptance values.* The modulus of rupture as determined by the Talbot strip test shall be 40 000 psi (275.8MPa) minimum.

The secant modulus of elasticity value shall not exceed 300 times the actual value of the modulus of rupture. [For example: when the modulus of rupture is 40 000 psi (275.8MPa) the secant modulus of elasticity shall not exceed 12 000 000 psi (82.7 GPa).]

6–12.1.3. *Test method.* Talbot strips (Fig. 6.1) shall be machined longitudinally from each pipe specimen selected for testing by this method. The Talbot strips may be cut from a part of the ring little stressed in the ring test—that is, near one of the elements marked *a* in the illustration of the ring test (Fig. 6.3). The strips in any case shall be in cross section as indicated in Fig. 6.1—that is, shall have for their width the thickness of the pipe and for their depth 0.50 in. (12.7 mm). Their length shall be at least $10\frac{1}{2}$ in. (266.7 mm). The strips shall be tested as beams on supports 10 in. (254.0 mm) apart with loads applied perpendicularly to the machined faces at two points $3\frac{1}{3}$ in. (84.7 mm) from the supports. The breaking load and the deflection shall be observed and recorded.

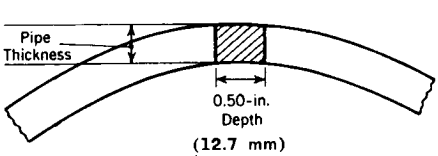

Fig. 6.1. Position From Which Talbot Strip is Cut

The strip shall be accurately calipered at the point of rupture and the modulus of rupture R shall be calculated by the usual beam formula, which for this case reduces to the expression

$$R = \frac{Wl}{td^2}$$

The secant modulus of elasticity, E_s, shall be computed by the formula

$$E_s = \frac{0.213\ Rl^2}{dy}$$

In the above formulas, R is the modulus of rupture, psi (MPa); E_s, the secant modulus of elasticity, psi (MPa); l, the span between supports, in. (mm), intended to be 10 in. (254.0 mm); W, the breaking load, lb (N); d, the depth, in. (mm) of the strip, intended to be 0.50 in. (12.7 mm); t, the width, in. (mm) of the strip, pipe thickness; and y, the deflection, in. (mm) of the strip at the center at breaking load.

Deflection measurements shall be that of the specimen and shall not include any compression of the supports or loading blocks, or backlash or distortion of the testing machine.

6–12.2. *Hardness tests.* Hardness tests shall be made on the outside surface of pipe. A sufficient number of pipe shall be tested to assure that the hardness does not exceed Rockwell B-95, or its equivalent. Pipe may be heat-treated to meet this requirement.

For the purpose of foundry records, hardness tests shall be made on a specimen from each Talbot strip selected for testing in Sec. 6–12.11. Rockwell B hardness determinations shall be made in accordance with ASTM E18–67 on the following surfaces at their approximate centers: (a) the outside pipe surface, (b) the inside pipe surface, and (c) either of the two cut sur-

Documents
Document Sharing Hub
Full document details: ANSI AWWA C106 - A21.6-80 scan