



THIS POLICY DOES NOT HAVE THE FORCE OF LAW

Policy for Determining the Acceptability of ASTM pipe in lieu of AWWA pipe for Public Water Systems

Division: DDAGW
Number: ENG-08-002
Category: Engineering - Policy
Status: Final
Issued: November 4, 2010

I. PURPOSE

The purpose of this policy is to establish standard criteria which may allow public water systems to use American Society for Testing and Materials (ASTM) pipe in lieu of American Water Works Association (AWWA) pipe.

II. BACKGROUND AND OBJECTIVES

Changes made between the 1997 and 2003 editions of the *Recommended Standards for Water Works* (Ten States Standards), effectively eliminated the allowable use of non-AWWA pipe for pipe 4 inches in diameter or greater.

The 1997 edition, Section 8.0.1 *Standards and materials selection* stated "Pipe, fittings, valves and fire hydrants shall conform to the latest standards issued by the AWWA **and/or** NSF, if such standards exist, and be acceptable to the reviewing authority..." (Bold added for emphasis)

The 2003 edition, Section 8.1.1 *Standards and materials selection* states "a. All materials including pipe, fittings, valves and fire hydrants shall conform to the latest standards issued by the AWWA **and** ANSI/NSF, where such standards exist, and be acceptable to the reviewing authority..." (Bold added for emphasis)

In actuality, the use of ASTM pipe continued to be approved by several of the member states, including Ohio. As such, the latest revision to the Ten States Standards again incorporates the use of ASTM pipe.

The 2007 edition, Section 8.1.1 *Standards and materials selection* states "a. All materials including pipe, fittings, valves and fire hydrants shall conform to the latest standards issued by the **ASTM**, AWWA and ANSI/NSF, where such standards exist, and be acceptable to the reviewing authority..." (Bold added for emphasis)

As such, the objective of this policy is to provide well defined criteria for when the use of ASTM pipe may be "acceptable to the reviewing authority" so its use can be consistently reviewed across the state.

Specifications:

The AWWA C900 standard includes manufacturing, quality-control standards and pressure classes for PVC pipe from 4 inches to 12 inches in diameter. AWWA Standard C605 addresses

installation and hydrostatic pressure testing of PVC pipe. AWWA Standard C651 covers disinfection procedures.

The ASTM D2241 standard only addresses the manufacturing specifications and testing procedures of the pipe itself.

The AWWA dimension ratios (DRs) differ from the ASTM standard thermoplastic pipe dimension ratios (SDRs) although both are determined by dividing the average outside diameter of the pipe by the minimum wall thickness.

The AWWA C900 standard has three dimension ratios for three pressure classes: DR25 (pressure class 100), DR18 (pressure class 150) and DR14 (pressure class 200). These pressure classes are established with a safety factor of 2.5 (Note: in practice, DR25 pipe is rarely specified). The AWWA standard includes an additional surge allowance (30 psi for DR25; 35 psi for DR18 and 40 psi for DR14), where ASTM D2241 does not. The pressure class is based on a hydrostatic design basis rating of 4000 psi.

The ASTM D2241 standard includes a greater range of standard dimension ratios: SDR 64, SDR 41, SDR 32.5, SDR 26, SDR 21, SDR 17 and SDR 13.5 (the lower the SDR number, the greater the pressure rating, i.e. greater wall thickness). ASTM D2241, Annex A.1, covers SDR 81, SDR 51, SDR 35 and SDR 11 pipe. The standard's pressure rating is typically based on a safety factor of 2.0 but other safety factors can also be used. The pressure rating corresponding to the allowable SDR ratios are (at a safety factor of 2.5): SDR 32.5 (100 psi); SDR 26 (128 psi); SDR 21 (160 psi); SDR 17 (200 psi); SDR 13.5 (252 psi). The pressure rating is based on a hydrostatic design stress of 2000 psi for Type 1, Grade 1 PVC 1120.

The AWWA C900 standard for polyvinyl chloride (PVC) pressure pipe and fabricated fittings, 4" through 12", uses a safety factor of 2.5 and provides for a surge pressure allowance, based on an instantaneous velocity change of 2 ft/s. The AWWA C905 standard for polyvinyl chloride (PVC) pressure pipe and fabricated fittings, 14" through 48", uses a safety factor of 2.0 and does not provide for a surge pressure allowance in the pipe pressure rating. A surge pressure allowance is included in the pipe working pressure rating under AWWA C905.

III. APPLICABLE REGULATIONS

Ohio Revised Code (ORC) section 6109.07 *Approval of construction or installation plans; notice of violation.*

Ohio Administrative Code (OAC) rule 3745-91-02 *Application for approval of plans.* "(A) No person shall begin construction or installation of a public water system, or make a substantial change in a public water system, until plans therefor have been approved by the director of environmental protection unless exempted pursuant to paragraph (D) of this rule. An application for approval of plans for such construction, installation, or substantial change in a public water system, as required by section 6109.07 of the Revised Code, shall be submitted to the district office...."

Ohio Administrative Code (OAC) rule 3745-91-08 *Procedure for approval; changes.* "The following shall be used as a guide in the technical review of plans submitted under this chapter of the Administrative Code:

... (2) The Great-Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers' "Recommended Standards for Water Works" (2007)"

IV. OTHER APPLICABLE GUIDANCE

American Water Works Association (AWWA) Standard C605, *Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.*

American Water Works Association (AWWA) Standard C651, *Disinfecting Water Mains.*

American Water Works Association (AWWA) Standard C900, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. (100 mm Through 300 mm), for Water Distribution.*

American Water Works Association (AWWA) Standard C905, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. Through 48 in. (350 mm Through 1,200 mm), for Water Transmission and Distribution.*

ASTM D2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, *Recommended Standards for Water Works*; 2007 Edition.

NSF International (NSF)/American National Standards Institute (ANSI) Standard 14, *Plastics Piping System Components and Related Materials.*

NSF International (NSF)/American National Standards Institute (ANSI) Standard 61, *Drinking Water System Components - Health Effects.*

Ohio EPA, *Guidelines for Design of Small Public Ground Water Systems*; Fourth Edition (also referred to as "The Green Book"). April 2010.

Uni-Bell PVC Pipe Association, *Handbook of PVC Pipe: Design and Construction*; Fourth Edition.

V. POLICY

The use of ASTM pipe may be acceptable in lieu of AWWA pipe for use in public water systems if all of the following conditions are met:

- All pipe used for potable water should be evaluated, tested and certified to meet NSF/ANSI Standards; and.
- The pipe is disinfected in accordance with AWWA standard C651; and
- The pipe is installed in accordance with AWWA standard C605; and
- SDR21 or thicker pipe should be used. Problems may be encountered with the installation and/or operation/serviceability of the thinner walled pipe (i.e. SDR26, SDR32.5, SDR41 or SDR64), even if the equivalent pressure class of the pipe is adequate to meet the pressure demands of the proposed project; and

- Ten States Standards Section 8.2.2 states “The minimum size of water main which provides for fire protection and serving fire hydrants shall be six-inch diameter. Larger size mains will be required if necessary to allow the withdrawal of the required fire flow while maintaining residual pressure specified in Section 8.1.1.

The minimum size of water main in the distribution system where fire protection is not to be provided should be a minimum of three (3) inch diameter. Any departure from minimum requirements shall be justified by hydraulic analysis and future water use, and can be considered only in special circumstances.”

- The maximum pressure for the ASTM pipe should be calculated using a safety factor of 2.5 and a surge pressure allowance of no less than 2 ft/sec.

In accordance with the AWWA standard (Section 4.7 Pressure-Class Designations), the pressure class of the pipe is calculated using the following equation:

$$PC = \left[\frac{2}{DR - 1} \times \frac{HDB}{F} \right] - P_s$$

Where:

- PC = Pressure class, in psi
- DR = Dimension ratio
- HDB = Hydrostatic design basis, which for the AWWA standard is 4000 psi
- F = Safety factor, which will be 2.5
- P_s = Surge pressure allowance, in psi, based on an instantaneous velocity change of 2 fps.

The surge pressure is calculated in accordance with Chapter 5 of the *Handbook of PVC Pipe: Design and Construction*, wave velocity equation:

$$a = \frac{4660}{\sqrt{1 + (k/E)(DR - 2)}}$$

- a = wave velocity, fps
- k = fluid bulk modulus, 300,000 psi for water
- DR = pipe OD/thickness = SDR
- E = Modulus of elasticity of the pipe, 400,000 psi for PVC

Then the maximum pressure surge is calculated as:

$$P_s = \frac{aV}{2.31g}$$

- P_s = pressure surge, psi
- V = maximum velocity change, fps
- g = acceleration of gravity, 32.2 fps²

Example: The project proposes to use 6" ASTM SDR 26 pipe in lieu of AWWA C900 pipe.

The wave velocity would be:

$$a = \frac{4660}{\sqrt{1 + (300,000/400,000)(26 - 2)}} = 1069 \text{ fps}$$

The maximum surge pressure would be:

$$P_s = \frac{1069 \times 2}{2.31 \times 32.2} = 29 \text{ psi}$$

The equivalent pressure class of the pipe would be:

$$PC = \left[\frac{2}{26 - 1} \times \frac{4000}{2.5} \right] - 29 = 99 \text{ psi}$$

As such, ASTM SDR 26 pipe (pressure rating of 128 psi) would not be adequate for use in water line projects where the system pressure will reach more than 99 psi. The project could use thicker ASTM pipe to meet the pressure requirements, such as SDR 21 pipe, which has a pressure rating of 160 psi and an equivalent pressure class of 128 psi.

The calculated pressure surges for a 2 fps instantaneous flow velocity change for ASTM pipes are: SDR 32.5 (26 psi); SDR 26 (29 psi); SDR 21 (32 psi); SDR 17 (36 psi) and SDR 13.5 (40 psi).

The following table lists the calculated equivalent pressure class for ASTM pipes:

ASTM SDR	Pressure Rating (psi)	Surge Allowance (psi)	Equivalent Pressure Class (psi)
32.5	100	26	74
26	128	29	99
21	160	32	128
17	200	36	164
13.5	252	40	212

When ASTM pipe is proposed in lieu of AWWA pipe, the applicant is responsible for providing the information necessary to show that the above criteria will be met. This information is to be submitted as part of the detail plan package and should include a pressure profile of each section of the proposed distribution system (the minimum pressure should be shown to ensure adequate pressure is maintained in the system and the maximum pressure should be shown to ensure the proposed pipe is adequate throughout the pressure range).

It should be noted that the reviewing authority may not recommend the use of ASTM pipe, where an AWWA standard exists, even if all the conditions noted above are met if other factors suggest that ASTM pipe should not be used for the proposed project. ASTM pipe may not be acceptable for a given project due to local water requirements such as City specifications requiring the use of AWWA pipe.

VI. HISTORY

The Division of Drinking and Ground Waters finalized this document on March 26, 2007. The document was revised on November 4, 2010 to align it with the 2007 edition of the *Recommended Standards for Water Works* (Ten States Standards) and revisions to the plan approval rules.