RECOMMENDATIONS FOR AWWA C901 SERVICE TUBES IN POTABLE WATER APPLICATIONS

PPI TN-49

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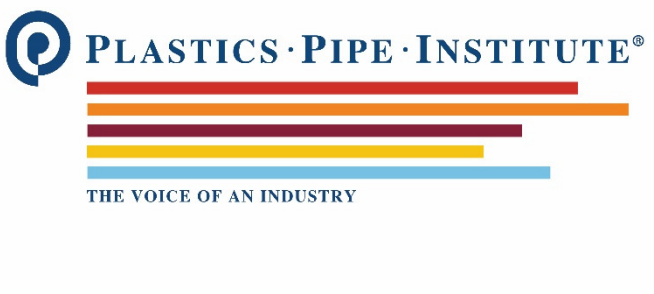

Foreword

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This technical note was developed and published with the technical help and financial support of the members of the Plastics Pipe Institute (PPI). These members have shown their commitment to developing and improving quality products by assisting standards development organizations in the development of standards, and also by developing design aids and reports to help engineers, code officials, specifying groups, contractors and users.

The purpose of this technical note is to provide general information about the history of the development of high-density polyethylene (HDPE) conduit and the various standards which apply to these products. The technical note may also be used as a guide for selecting appropriate standard specifications for users and specifiers.

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The Plastics Pipe Institute, Inc.

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1. INTRODUCTION

On June 11, 2017, the American Water Works Association approved the newly revised and updated standard ANSI/AWWA C901-17 "Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. (19 mm) Through 3 In. (76 mm), for Water Service." The Standard now requires the use of only high performance PE4710 compounds with SDR9/SIDR7 for service tubes and requires that "PE Compound used in potable water service applications shall be classified [for resistance to the oxidative effects of disinfectants] as CC2 or CC3 per ASTM D3350..."

Based on these AWWA C901 requirements, this PPI Technical Note provides a quick and simple guide for the selection of PE water service tubes for use in potable water applications with chlorine and chloramine disinfectant residuals. Users can compare their operating conditions to the Quick Selection Table to determine whether additional analysis is required. Most users will find their operating environment readily satisfied by specifying compounds with the highest oxidative resistance performance class, e.g. CC3, and will achieve projections of 100 year+ resistance to the disinfectants.

This Technical Note addresses chlorine and chloramine usage as a secondary disinfectant. Chlorine Dioxide (ClO_2) as a secondary disinfectant residual is not covered by this guidance. At this time, PE pipe is not recommended with these ClO_2 applications because further research is needed to determine performance. Refer to the pipe manufacturer for ClO_2 applications.

2. BACKGROUND

Polyethylene (PE) pipes intended for potable water applications contain additives to provide resistance to the long-term oxidizing effects of water disinfectants. Research programs conducted on PE piping compounds resulted in the development of a model that projects the performance of PE pipes in long-term chlorinated potable water service.[1] The model is based on accelerated testing of many PE compounds in accordance with ASTM F2263 *Test Method for Evaluating the Oxidative Resistance of Polyethylene (PE) Pipe to Chlorinated Water* and the model allows the projection of the performance of PE pipes to specific end-use service conditions.

PE pipe compounds specified for potable water applications are categorized for oxidative resistance performance in accordance with ASTM D3350 based on ASTM F2263 testing. Per AWWA C901, the acceptable oxidative resistance categories are CC3 (highest performance) and CC2. To simplify the quick selection method for AWWA C901 sizes, PPI TN-49 guidance is based on the use of the highest category PE compound, CC3.

[1] Jana Technical Report, "JP 916: Jana Mode 3 Shift Functions", March 2012

3. QUICK SELECTION METHOD

The operational service life of water service tubing piping system depends on many factors. The long-term resistance to disinfectants is one of these factors. To simplify the selection of PE service tubes in the vast majority of applications, PPI developed the TN-49 Quick Selection Table (Table 1 below) to provide users with an easy to assess 100-year oxidative resistance pipe solution.

Users specifying PE compounds with CC3 categorization and with operating conditions within Table 1 designated ranges have projected resistance to disinfectant conditions of at least 100 years.

For example:

- Utility A, using a PE 4710 CC3 compound, has an average annual water temperature of 60°F, an average **chlorine** residual of 1.1 ppm, average pH of 7.4, and an average working pressure of 125 psi. The chlorine residual and pH values are within the Quick Selection Table ranges, so the Quick Selection method applies and confirms the resistance to disinfectant conditions of at least 100 years for all AWWA C901 sizes.

- Utility B, using a PE 4710 CC3 compound, has an average annual water temperature of 73°F, an average **chloramine** residual of 2.2 ppm, average pH of 6.8, and an average working pressure of 250 psi. Table 1 indicates that there are no limits on chloramine residual and pH values. Thus, the Quick Selection Table confirms the resistance to disinfectant conditions of at least 100 years for all AWWA C901 sizes.

Table 1: TN-49 Quick Selection Table

PE Compound Oxidative Resistance Category	PE 4710 CC3				
Average Annual Water Temperature (ºF)*	≤ 73				
Residual Disinfectant Type	**Chloramine**	**Chlorine**			
Average Disinfectant Residual (ppm)	No limit	≤ 2.0			
Average pH	No limit	≥ 7.0			
Nominal Pipe Size (inches)**	≥ ¾	¾	1	2	3
Average Working Pressure (psig)	≤ 250	≤ 142	≤ 152	≤ 181	≤ 202
Projected Oxidative Resistance under the specific operating conditions (years)	≥ 100 years				

* The Average Annual Water Temperature (AAWT) is a weighted average of the daily water temperature, not the highest temperature observed in the system, experienced by the pipe or tubing. In situations where the service lines are buried just beneath the pavement, a higher water temperature estimate for the AAWT may be required.

** Dimensional Ratio SDR 9/SIDR 7 per AWWA C901

Users with operating conditions or pipe compound choice that fall outside the designated ranges in Table 1 should conduct an additional analysis per PPI TN-44[2] using factors for AWWA C901 sizes (i.e. F_{size}) specified in Table 2. Future updates to www.HDPEapp.com will include this analysis.

Table 2: F_{size} Factor for use in TN-44 calculations for AWWA C901 Pipe and Tubing

Nominal Pipe Size (inches)	**¾**	**1**	**1.25**	**1.5**	**2**	**3**
F_{size}	0.22	0.28	0.34	0.40	0.52	0.76

[2] PPI Technical Note 44, "Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants", Plastics Pipe Institute, Inc., USA, 2015

4. SPECIFYING THE PE PIPE COMPOUND

PE 4710 pipe compounds shall conform to the latest editions of AWWA C901, NSF Standards 14 & 61 and ASTM D3350. The outside diameter shall be based on the IPS, CTS or SIDR sizing system. The specifier should append the required chlorine category (CC) class to the typical ASTM D3350 cell classification call-out. Examples of call-outs are provided below; refer to ASTM D3350 for other cell classifications:

- PE 445574E CC3 - for colored with UV stabilizer meeting CC3 minimum oxidative resistance performance class
- PE 445574C CC3 - for black with a minimum of 2% carbon black meeting CC3 minimum oxidative resistance performance class

5. CASE STUDIES

Table 3 (below) shows case studies under the specific operating conditions for 10 utilities as analyzed per PPI TN-49. In all these applications, AWWA C901 PE4710 pipe is projected to provide at least 100-year resistance to chlorine and chloramine residual disinfectants; note that these systems include utilities with high average working pressure (Colorado, 250 psi), high average temperature (Florida, 79 ºF) and high average Cl_2/Low pH (Nevada, 1.1 ppm / 7.8). For conditions outside the TN-49 Quick Selection Table, PPI TN-44 was used to confirm projected performance of at least 100 years.

Table 3: Resistance to Disinfectants at Selected Utilities

Utilities Location	IN-1	CA-1	FL	TX	IN-2	NC	CO	CA-2	NV	MI
Residual Disinfectant Type	Chloramine*				Chlorine					
Nominal Size (inches)	¾" to 3" (SDR9/SIDR7 per AWWA C901)									
Average Disinfectant Residual (ppm)	1.6	1.9	1.4	2.5	1.4	0.9	0.5	0.9	1.1	1.5
Average pH	7.7	9.0	9.3	7.3	8.8	8.6	7.9	7.9	7.8	8.0
Average Annual Water Temperature (ºF)	57	61	79	72	54	68	50	64	70	48
Average Working Pressure (psig)	70	65	70	125	70	70	250	77	100	100
Projected Oxidative Resistance under the specific operating conditions (years)**	≥ 100 years									

* In 2014, it was "estimated that approximately 30% of municipal water utilities use monochloramine for residual disinfection … and that number is expected to increase to 60% as more-stringent DBP [Disinfectant By-Product] regulations go into effect…" Ref: Nagisetty, R., Rockaway, T. and Willing, G., *Drinking Water Quality Concerns from Chloramine-Induced Degradation of Elastomeric Compounds*, AWWA Journal, Sep. 2014.

**** Projected oxidative resistance under the specified operating conditions. In assessing the above case study examples, a projected life of at least 100-years was confirmed using both PE4710 CC2 and CC3, referring to PPI TN-44 as appropriate.**