

# PACE

## Pipeline Analysis & Calculation Environment

### Pipe Selection

PE Pipe Type: PE4710 DIPS 10" DR17  
 DI Pipe Type: DI DIPS 10" Thickness = 0.26"  
 PVC Pipe Type: PVC12454-B CIOD 10" DR18

### Input Summary

Pipeline Length 1000 ft  
 Design Velocity for Recurring Surge 4 ft/s  
 Design Velocity for Occasional Surge 8 ft/s  
 Anticipated Recurring Surges 55 per day  
 Temperature 57 degrees Fahrenheit  
 Working Pressure 70 psi  
 Minimum Design Life 100 years

### Calculated Results

Standard	AWWA-C906		AWWA-C151		AWWA-C900	
Resin	PE4710		DI		PVC12454-B	
Pipe Rating at 57°F	125		350		235	
Working Pressure (no surge) Check	OK		OK		OK	
Nominal OD [in]	DIPS 10		DIPS 10		CIOD 10	
Dimension Ratio / Thickness	17		0.26		18	
Average Inside Diameter [in]	9.72		10.46		9.79	
	Recur.	Occas.	Recur.	Occas.	Recur.	Occas.
Flow Rate [gpm]	924	1,849	1,070	2,140	939	1,878
Head Loss [psi]	2.0	7.4	2.1	7.7	2.0	7.3
Surge Pressure [psi]	45	90	204	408	70	139
Total Pressure [psi]	115	160	274	478	140	209
Allow. Total Press. (with surge) [psi]	188	250	450	450	235	376
Surge Pressure Check	OK	OK	OK	x	OK	OK
Number of Cycles To Failure	9.2 x 10 <sup>8</sup>		N/A		2.3 x 10 <sup>6</sup>	
Design Fatigue Life [years; SF = 2]	>100		N/A		58	
Design Fatigue Life Check	OK		N/A		x	

### Additional Design Parameters

Dynamic Elastic Modulus [psi]:	150,000	24,000,000	400,000
Hydrostatic Design Stress [psi]:	1,000	N/A	2,000
Temperature Derating Factor:	1	1	1
Hazen-Williams Factor:	150	140	150

## Calculation Procedures

- PPI-PACE is an online tool developed by eTrenchless Group Inc. that follows the design procedures in well-established and accepted water standards (ANSI/AWWA C150/151, ANSI/AWWA C900, ANSI/AWWA C901, ANSI/AWWA C905, ANSI/AWWA C906, ANSI/ASTM D2241).
- Per ANSI/AWWA C906, "Matching the ID of other pipe materials to the ID of HDPE for flow and PC will yield incorrect results. Use PPIPACE.com to evaluate flow capacity and PC of HDPE to other materials."
- Per ANSI/AWWA C906, "For PE4710, the PC calculations include a safety factor greater than 2 relative to the allowed operating stress..."
- Per ANSI/AWWA C906, "For PE4710, the SF for occasional surge pressure is pressure is greater than 2..."
- Per the AWWA and ANSI approvals of AWWA C906, the Hydrostatic Design Stress (HDS) of PE4710 is 1000 psi.
- Users can change the default values per project requirements.
- For Recurring Surge, PPI-PACE defaults to a minimum 4 fps flow velocity per AWWA M55; the software allows for a 4-8 fps range.
- For Occasional Surge, PPI-PACE defaults to a minimum 8 fps flow velocity per AWWA M55; the software allows for a 5-15 fps range.
- Average Flow Velocities: 6.7 fps (for Recurring Surge) and 11.6 fps (for Occasional Surge) per AWWA M55.
- For Working Pressure, PPI-PACE defaults to 70 psi - which is the average working pressure in the US. The minimum allowable value in PPI-PACE is 40 psi.
- For Anticipated Recurring Surges, PPI-PACE defaults to 55 cycles per day per AWWA C900-07 and AWWA C905-10 (Appendix B/Design Example); this results in about 1 million cycles for a 50-year design life and about 2 million cycles for a 100-year design life. It was recommended by one consultant to design for 3.5 million cycles or 96 cycles per day at a 100-year design life. The minimum allowable value in PPI-PACE is the default 55 cycles/day.
- For Temperature, PPI-PACE defaults to 57°F which is the average water temperature in the US; the software allows 40-100°F; consult the manufacturer for other temperatures.
- For Minimum Design Life, PPI-PACE defaults to 100 years; the software allows a minimum recommended design life of 50 years.
- For Help, refer to [Resistance of PE4710 Piping to Pressure Surge Events in Force Main Applications](#), PP XVI, Barcelona, 2012, [UK Water Industry IGN 4-37-02 Design Against Surge and Fatigue Conditions for Thermoplastic Pipes](#), and EPA [Water Research Foundation: Durability and Reliability of Large Diameter HDPE Pipe for Water Main Applications](#)
- The definition of pressure rating and pressure class differ between the implemented standards (AWWA C900, AWWA C905, AWWA C906, ASTM F714, ASTM D2241). The calculations on this site, provided by eTrenchless Inc., provide an unbiased interpretation of these standards so that an equivalent comparison of pipe materials can be conducted.
- Temperature derating factors for PE pipe in AWWA-M55 are limited to 100°F with a reference to manufacturers literature for temperatures greater than 100°F. ASTM F714 (PE) and AWWA-M23 (PVC) publishes temperature derating factors up to 140°F but these higher temperatures are not included in this tool.
- The design fatigue life for PVC is determined using the calculation method stated in AWWA C900 and C905 Appendix B using a 2:1 design factor. Data from tests with PE 4710 pipe are consistent with the UKWIR and Marshall/Brogden reports; see above reference and link to PP XVI Barcelona, 2012. For PE the design fatigue life is determined using fatigue curves provided in *Marshall, G.P., Brogden, S: Final report of Pipeline Innovation Contract to UKWIR, 1997* using a 2:1 design factor. For additional information on fatigue life and flow velocities see the Jana Laboratories report [here](#). The design fatigue life of Ductile Iron (DI) pipe is not shown in PPI-PACE since these calculations are not available or referenced in the DI AWWA Standards or Manuals.
- Pressure rating should be reduced for systems operating under special or unusual conditions or where the pipe transports fluids that are known to have some degrading effect on the properties of polyethylene or where specified in Codes or Regulations or by the authority having jurisdiction. Water is the assumed transport fluid on PPI-PACE.
- Occasional transients caused by emergency pump and valve operations are usually severe. The system should be designed to withstand positive and negative pressures caused by these emergency operations. Water column



separation may occur if the negative pressure is reduced to the vapor pressure of the liquid. Rejoining of the separated water column typically results in a large pressure rise, which will possibly damage the pipe system. Whenever possible, water column separation should be avoided

- These are preliminary calculations for product comparison only, not for final design. Qualified professionals should be contracted to consider all aspects of the design for pressure pipe design.

For more information contact [support@ppipace.com](mailto:support@ppipace.com)

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This website is constructed to assist water distribution professionals in the selection of their product pipe by providing a pressure pipe design tool that is consistent with the existing standards. For polyethylene pipe, AWWA-M55 "PE Pipe - Design and Installation", ASTM F714-10 "Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter", AWWA C901-08 "AWWA Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) through 3 In. (76 mm), for Water Service", and AWWA C906-15 "AWWA Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks" are the applicable documents. For polyvinyl-chloride pipe (PVC), AWWA-M23 "PVC Pipe - Design and Installation", ANSI/AWWA C900-07 "AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution", AWWA C905-10 "AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm)", and ASTM D2241-05 "Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)" are the applicable documents. For ductile iron pipe (DI), AWWA-C150-14 "Thickness of Ductile Iron Pipe" and AWWA C151-09 "Ductile-Iron Pipe, Centrifugally Cast" are the applicable documents

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