WL PLASTICS
An INEOS Business

PE4710
Water Pipe

Water Applications

The ideal piping solution

WL Plastics PE4710 Pressure Water Pipe

WL Plastics is dedicated to the principle that customers should have the best in quality and service. WL Plastics quality begins with premium materials and state-of-the-art extrusion equipment because better materials and better processing yield a better product. Customer service begins with talking to people that can provide answers, not selecting voice-mail numbers.

WL Plastics opened its Mills, WY plant near Casper in 2000. Four years later, Cedar City, UT opened followed by Gillette, WY in late 2004.Bowie, TX opened in 2005, followed by Crossfield, AB Canada in 2007, Elizabethtown, KY in 2010, Snyder, TX in 2012, Rapid City, South Dakota in 2014, an additional building added to our Bowie, TX location in 2014 and a new plant located in Statesboro, GA for 2016. Such growth validates WL Plastics focus and dedication to quality products and customer service.

WL Plastics PE4710 pressure-rated polyethylene

WL Plastics PE4710 polyethylene has enhanced long-term and short-term strengths for extended service and reliability in demanding applications. WL Plastics PE4710 is the highest performing PE4710 available.

- WL Plastics PE4710 pressure-rated polyethylene compound meets or exceeds ASTM D 3350 Cell Classification PE445574C.
- WL Plastics PE4710 pressure-rated polyethylene has PPI Listed HDB ratings at 73°F and at 140°F and PPI Listed HDS ratings for water at 73°F. See the table below.
- For potable water service, WL Plastics PE4710 polyethyleneis certified to NSF-61 by the National Sanitation Foundation.

WL Plastics PE4710 – Physical Property (Plaque)	**Test Method**	**Typical Value**
Tensile strength at yield (2in/min)	ASTM D638	3500<4000 psi
Tensile elongation (2in/min)	ASTM D638	>400%
Flexural modulus	ASTM D790	>120,000 psi
SCG Resistance, PENT (80°C, 2.4 MPa)	ASTM F1473	>500 h
Impact Resistance	ASTM D256 (Izod)	>20 ft-lb/in
	ASTM F2231 (Charpy)	>14 ft-lb/in2
Brittleness temperature	ASTM D746	<-103°F (<-75ºC)
WL Plastics PE4710 – Physical Property (Pipe)	**Test Method**	**Typical Value**
PPI TR-4 Listed HDB for water at 73°F (23ºC)	ASTM D2837 & PPI TR-3	1600 psi (11.0 MPa)
PPI TR-4 Listed HDS for water at 73°F (23ºC)	ASTM D2837 & PPI TR-3	1000 psi (6.9 MPa)
PPI TR-4 Listed HDB at 140°F (60ºC)	ASTM D2837 & PPI TR-3	1000 psi (6.9 MPa)
HDS for water at 140ºF (60ºC)	ASTM D2837 & PPI TR-3	630 psi (4.3 MPa)
RCP Resistance, Critical Pressure at 32ºF (0ºC)	ISO 13477	>174 psi (>1.2 MPa)
RCP Resistance, Critical Temperature at 72.5 psi (0.5 MPa)	ISO 13477	<2ºF (<-17ºC)

Typical values for compound physical properties determined by testing plaque or pipe specimens in accordance with the test method. Values for pipe may vary.

What does “pressure-rated” mean?

The predominant use for plastics is packaging where a container is used for a short time and then discarded (preferably recycled). Piping products, however, must perform for decades in environments that quickly degrade most materials. Unlike plastic packaging, piping materials must be highly engineered for extended service in pressure water systems. To assure performance in pressure piping, plastic piping materials are tested for HDB and HDS ratings per ASTM and PPI standards. Pipe pressure class ratings are then determined using the HDB and HDS ratings.

HDB and HDS ratings that are verified by the Hydrostatic Stress Board are typically listed in PPI TR-4. PPI Listing in TR-4 is your assurance that products made from PPI Listed materials are suitable for a lifetime of pressure service. Without PPI HDB and HDS Listings, there is no independent verification that plastic pipe will provide long-term pressure service.

Two PPI Listings are available – **Independent** and **Dependent**. An **Independent Listing** is acquired from the PPI Hydrostatic Stress board by a resin manufacturer. Independent Listing is based on:

- A specific, defined formulation for the plastic material;
- Long term testing of piping products made from the formulation;
- Evaluating test data per PPI and ASTM standards to determine the formulation’s HDB and HDS ratings.
- The formulation cannot be modified or altered without reconfirming HDB and HDS ratings.
- The resin manufacturer specifies how to process (extrude or mold) the formulation so that products made from the formulation have the same HDB and HDS ratings.

A **Dependent Listing** is acquired from the PPI Hydrostatic Stress Board by the processor (extruder or molder). Dependent Listing is based on:

- Using the specific formulation in accordance with the Independent Listing;
- Adhering to Independent Listing processing specifications to make piping products;
- Evaluation of the processor’s piping products for compliance with Independent Listing long term HDB and HDS performance ratings;
- Independent Listing holder confirmation to PPI that the processor used the specified formulation and processed in accordance with specifications, and that the products made were in conformance with the Independent Listing.

WL Plastics PE4710 material has Independent Listings and Dependent Listings that are published in PPI TR-4 so that customers may verify that WL Plastics PE4710 pipes are in fact suitable for pressure service.

Unlisted materials offer no assurance that products made from the unlisted material are suitable for pressure service. Without published PPI Listings a user cannot independently verify that a plastic material has HDB or HDS ratings – the basis for pressure piping service. **A PVC cell classification per ASTM D1784 does not qualify a PVC material for pressure service because ASTM D1784 cell classification requirements do not exclude proprietary formulation modifications, and because ASTM D1784 does not require HDB or HDS ratings.** PPI Listed HDB and HDS ratings are fundamental independent assurance of quality pressure piping products. If PPI doesn’t list HDB or HDS ratings for the material, it could be a signal flag for higher user risk or unreliable service.

Why should you use WL Plastics PE4710 instead of PVC?

In a word – toughness. No other water piping product offers the balance of performance and quality that you get with WL Plastics PE4710.

Property	WL Plastics PE4710	PVC	Difference
Tensile elongation at break	>700%	<50%	>14 to 1
Glass Transition (brittleness) Temperature	Ductile above -103°F	Brittle below +170°F	PE4710 is ductile for all operating temperatures. PVC is brittle for all operating temperatures
Impact Resistance	>20 ft-lb/in (Izod) >14 ft-lb/in2 (Charpy)	<0.65 ft-lb/in (Izod)	>14 to 1
RCP Resistance	>174 psi at 32°F	<29 psi at 32°F	>6 to 1
Water Hammer pressure surge	Up to 100% of PC	≤60% of PC	1.7 to 1
Cyclic Surge Resistance	250 million cycles	1 million cycles	250 to 1
Pipe Bending Radius	<30 x OD	>200 x OD (B & S) >250 x OD (fused)	>6.7 to 1 >8 to 1
Ring Deflection	Up to 100%	Up to 40%	2.5 to 1

Toughness and ductility vs. brittleness

Why are toughness and ductility important in pressure piping? Toughness is resistance to suddenly applied stress – impact, water hammer, RCP, cyclic fatigue, soil subsidence, earthquake. Did you know that high density polyethylene pipe is the material of choice for fireworks mortar tubes? It's considered the safest material because it doesn't shatter if a fireworks shell explodes in the tube.

Ductility is the ability to deform rather than fracture under more slowly applied stress. It is also referred to as strain tolerance. Ductile materials have the ability to safely handle localized stresses such as rock impingement or localized deformation from lower quality installation or lateral deflection from soil subsidence or seismic events. Ductility means safely supporting loads that will cause brittle higher strength materials to fracture. Even if fracture does occur, the energy absorbing qualities of ductile-elastic materials quickly lead to fracture arrest. Brittle strain sensitive materials like PVC are more readily fractured and have low capacity for fracture arrest.

A measure of fracture toughness is RCP resistance. RCP or rapid crack propagation in pressure pipe is where a fast running crack splits the pipe lengthwise. RCP resistance is a special concern for pressurized gas pipelines, but also results from internal water pressure and entrapped air that is compressed and pressurized in pressure water piping. When the split starts, embedment soil around the pipe keeps the split from opening up and quickly dissipating internal pressure so the split keeps going until internal pressure dissipates enough for the split to arrest. RCP is a particular concern for fused piping systems because a fracture can run from length to length right through fusions.

To prevent RCP, fusion joined systems need to be ductile materials with high RCP resistance and crack arrest capability. There are no RCP requirements for fused PVC piping, but RCP requirements for PE piping require arrest within five pipe diameters.

What is a safety factor?

Recently, there has been a lot of talk and misinformation about safety factors for thermoplastic piping. To understand the various perspectives, we should first discuss safety factors and what they do.

A safety factor is a specified reduction of a particular strength property. A safety factor differs from a design factor that is based on engineering evaluations of risk and reliability. Specified reduction safety factors are frequently related to safety Codes and Regulations. Examples of specified reductions are maximum operating pressures for gas pipes that are specified in Federal Codes and Regulations.

Unlike specified reduction safety factors, design factors result from risk and reliability evaluations of various conditions and properties, and are the summation of the evaluations into a single design factor. Examples are the design factors for thermoplastic pressure piping developed by the Hydrostatic Stress Board.

In the late 1960s when the North American plastic pipe industry was in its infancy, the Hydrostatic Stress Board developed design factors that would assure reliable thermoplastic plastic pressure piping. For water piping, they first developed long-term pressure rating policies and procedures (material HDB ratings), and then considered where uncertainty could be introduced. The engineering variables considered were:

- Testing variability among laboratories
- Extending the HDB from 100,000 hours to 50 years
- Plastic compound lot to lot variations
- Variations among plastic compounds that have the same classification
- Variations among plastic pipes from different extrusion processors and plants
- The effects of operating pressure variations on plastic pipe
- The effects of variations in handling and installation
- Unknown effects

The HSB then assigned reduction values to each of the variables, and summed them with the result being the familiar 0.50 design factor multiplier (2.00 divisor) that has been applied to plastic water piping for nearly five decades. It incorporates risk and reliability evaluations where a safety factor does not.

HSB policy and practice are incorporated into ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products*, which is the standard for determining pressure rating for **all** thermoplastic pressure piping including PE and PVC.

5.5 Hydrostatic Design Stress – Obtain the hydrostatic design stress by multiplying the hydrostatic design basis by a service (design) factor selected for the application on the basis of the two general groups of conditions. The first group considers the manufacturing and testing variables, specifically normal variations in the materials, manufacture, dimensions, good handling techniques, and in the evaluation procedures in this test method and in Test Method D1598 (Note 8).The second group considers the application or use, specifically installation, environment, temperature, hazard involved, life expectancy desired, and the degree of reliability selected (Note 9). Select the service factor so that the hydrostatic design stress obtained provides a service life for an indefinite period beyond the actual test period.

Section 5.5 (left) describes how design factors are developed. The HSB design factors applied to PE and PVC pipe pressure ratings incorporate much more than a safety factor reduction of a particular mechanical property.

Reviewing the design factor variables that the HSB considered, 1 through 6 relate to product quality and performance, and 7 and 8 relate to the application. Material performance is the single largest component of the design factor. When plastic piping materials are compared to the HSB DF variables, the difference between WL Plastics PE4710 and PVC is clear.

	HSB DF Variable	PE4710	PVC	Difference
1	Testing variability among laboratories	↔	↔	Same ASTM and PPI standards
2	Extending the HDB from 100,000 hours to 50 years	↑	↓	PE4710 HDB must be substantiated at 50 years; PE4710 pressure piping standards and ASTM D3350 cell classification require HDB and HDS rated materials. No HDB substantiation for PVC; ASTM D1784 cell classification 12454 does not require HDB or HDS ratings.
3	Plastic compound lot to lot variations	↑	↓	Less PE4710 variation – PE4710 formulation is controlled through independent PPI Listings and ASTM D3350 cell classification. PVC ASTM D1784 cell classification does not restrict proprietary formulation modifications
4	Variations among plastic compounds that have the same classification	↑	↓	Less PE4710 variation – PE4710 must qualify for HDS rating by meeting increased performance requirements
5	Variations among plastic pipes from different extrusion processors and plants	↑	↓	Less PE4710 variation – PE4710 pipe is qualified as pressure pipe through PPI dependent listing of the pipe manufacturer. Published ratings are readily confirmed. Pressure ratings for PVC materials without published listings cannot be confirmed. Without HDB and HDS ratings, suitability for pressure service is unknown.
6	The effects of operating pressure variations on plastic pipe	↑↑↑	↓	PE4710 is ductile, has much greater surge resistance and much greater RCP resistance. PVC is brittle, has lower surge pressure capacity and significantly lower RCP resistance.
7	The effects of varying quality in handling and installation	↑↑	↓	PE4710 is more flexible, has significantly better impact resistance and has greater tolerance to localized impingement stresses. PVC is brittle, has low impact resistance and is sensitive to localized stress.
8	Unknown effects	↔	↔	PE4710 and PVC will respond to unknown effects depending on the conditions imposed and the material performance property affected.

When it comes to water piping, there are differences among materials. If there weren't, AWWA wouldn't publish different Manuals of Practice for different piping materials and there wouldn't be different standards for water piping products. These differences mean that design pressure ratings are dependent on the material's performance in water piping systems.

Following the same engineering evaluation procedure, the Hydrostatic Stress Board performed an engineering evaluation of PE4710 and set three higher performance requirements. The only way to meet PE4710 performance specifications is with improved PE material. When these new requirements are met, the hydrostatic design stress (HDS) rating for PE4710 materials for water is 1000 psi, where conventional

unimproved HDPE is limited to 800 psi. Similarly, unimproved PVC materials are limited to HDS ratings in accordance with 0.50 design factor limitations.

WL Plastics PE4710 qualifies for higher design factor and higher HDS rating because the piping material is improved and meets higher performance requirements. (See WL123.)

DIPS sizes & pressure classes (WL104)

DIPS Size	Average OD (inch)	Average ID (inch) PC350	PC 300	PC 250	PC 200	PC 150	PC 100
4	4.80	2.707	3.478	3.669	3.875	4.088	4.315
6	6.90	3.281	5.000	5.000	5.570	5.877	6.203
8	9.05	4.717	6.558	6.558	7.306	7.708	8.136
10	11.10	6.186	8.044	8.044	8.961	9.454	9.979
12	13.20	7.588	9.566	9.566	10.656	11.243	11.867
14	15.30	9.023	11.088	11.088	12.351	13.032	13.755
16	17.40	10.459	12.609	12.609	14.047	14.820	15.643
18	19.50	11.894	14.131	14.131	15.742	16.609	17.531
20	21.60	13.330	15.653	15.653	17.437	18.398	19.419
24	25.80	—	18.697	18.697	20.828	21.975	23.195
30	32.00	—	—	23.190	25.833	27.256	28.770

IPS sizes & pressure classes (WL102)

IPS Size	Average OD (inch)	Average ID (inch) PC 315	PC 250	PC 250	PC 200	PC 125	PC 100
1 1/2	1.900	1.348	1.452	1.534	—	—	—
2	2.375	1.685	1.816	1.917	—	—	—
2 1/2	2.875	2.040	2.198	2.321	—	—	—
3	3.500	2.484	2.676	2.825	2.950	3.064	3.147
4	4.500	3.193	3.440	3.633	3.793	3.939	4.046
6	6.625	4.701	5.064	5.348	5.585	5.799	5.956
8	8.625	6.120	6.593	6.963	7.271	7.549	7.754
10	10.750	7.628	8.218	8.678	9.062	9.409	9.665
12	12.750	9.047	9.747	10.293	10.748	11.160	11.463
14	14.000	9.934	10.702	11.302	11.801	12.254	12.587
16	16.000	11.353	12.231	12.916	13.487	14.005	14.385
18	18.000	12.773	13.760	14.531	15.173	15.755	16.183
20	20.000	14.192	15.289	16.145	16.859	17.506	17.981
24	24.000	17.030	18.347	19.375	20.231	21.007	21.577
30	30.000	—	22.933	24.218	25.289	26.259	26.971
36	36.000	—	—	29.062	30.347	31.511	32.366
42	42.000	—	—	—	—	36.762	37.760
48	48.000	—	—	—	—	42.014	43.154
54	54.000	—	—	—	—	47.266	48.549

Sizes available in coils. All sizes available in 40 ft. or 50 ft. lengths. For water flow calculations, average ID is calculated using minimum wall thickness plus ½ of wall thickness tolerance.

WL Plastics PE4710 fusion, joining and installation

WL Plastics PE4710 is joined using butt fusion, electrofusion and standard mechanical joint or flanged joint waterworks connections. Services are connected to pressure or non-pressure mains using sidewall fusion, sidewall electrofusion or mechanical saddles.

Industry standards for fusion joining

Joint Type	PE4710	PVC
Butt Fusion	ASTM F2620, PPI TR-33	None
Electrofusion	ASTM F1734	None
Sidewall (saddle) fusion	ASTM F2620, PPI TR-41	None
Sidewall electrofusion	ASTM F1734	None
Butt Fusion Testing	ASTM F2634	None
Electrofusion Testing	ASTM F1055, ASTM F905	None
Sidewall Fusion Testing	ASTM F905	None

Industry standards for installation

Installation	PE4710	PVC
Direct Burial	ASTM D2774, ASTM F1668	ASTM D2774, ASTM F1668
Sliplining	ASTM F585	None
Horizontal Directional Drilling	ASTM F1962; ASCE MOP 108	None
Safe Pull-In Load	ASTM F1804	None
Hydrostatic Leak Testing	ASTM F2164	None
Disinfection	AWWA C651	AWWA C651

Minimum bending radius – IPS pipe

IPS Pipe Size	PE4710	PVC		IPS Pipe Size	PE4710	PVC	
		B & S	Fused			B & S	Fused
1 1/2	5 ft	32 ft	–	16	40 ft	267 ft	333 ft
2	6 ft	40 ft	–	18	45 ft	300 ft	375 ft
2 1/2	7 ft	48 ft	–	20	50 ft	333 ft	417 ft
3	9 ft	58 ft	73 ft	24	60 ft	400 ft	500 ft
4	11 ft	75 ft	94 ft	30	75 ft	500 ft	–
6	17 ft	110 ft	138 ft	36	90 ft	600 ft	–
8	22 ft	144 ft	180 ft	42	105 ft	700 ft	–
10	27 ft	179 ft	224 ft	48	120 ft	800 ft	–
12	32 ft	213 ft	266 ft	54	135 ft	–	–
14	35 ft	233 ft	292 ft				

Minimum bending radius – IPS pipe

DIPS Pipe Size	PE4710	PVC		DIPS Pipe Size	PE4710	PVC	
		B & S	Fused			B & S	Fused
4	12 ft	80 ft	100 ft	16	44 ft	290 ft	363 ft
6	17 ft	115 ft	144 ft	18	49 ft	325 ft	406 ft
8	23 ft	151 ft	189 ft	20	54 ft	360 ft	450 ft
10	28 ft	185 ft	231 ft	24	65 ft	430 ft	438 ft
12	33 ft	220 ft	275 ft	30	80 ft	533 ft	667 ft
14	38 ft	255 ft	319 ft				

Comparative water flows and pressures – PE4710 vs. PVC

Water hammer surge pressure can occur when flow suddenly changes. Water piping comparison covers flow rate, operating pressure and surge pressure, not just pressure rating.

PE4710 is a resilient, ductile piping material that accommodates water hammer pressure surges using standard allowances that are applied above the pipe's PC. For repetitive surge, the allowance is 50% of the PC, and for occasional surge, 100% of the PC. Both allowances are applied above the pipe's PC; that is, during a water hammer surge event, the allowable pressure in the pipe is the PC plus the surge allowance.

For brittle PVC pipes, repetitive surge pressure is deducted from the pipe's PC. The allowance for occasional surge is 60% of the pipe's PC.

For WL Plastics PE4710 and PVC pipes having comparable inside diameters, the chart above illustrates how WL Plastics PE4710 and PVC pipes compare for repetitive surge pressure conditions of equivalent flow velocity, equivalent flow rate, and equivalent maximum operating pressure.

	Nom Size	PC	lb/ft	Avg ID in	V fps	Q gpm	Surge Pressure psi	Surge Allowance psi	Max Op Pressure psi
PE4710	8" DIPS	150	7.35	7.708	5.0	727	61.9	75	150.0
PVC	8" IPS	235	7.86	7.609	5.0	708	86.8	–	148.2
PVC	8" IPS	235	7.86	7.609	5.1	727	89.1	–	148.2
PVC	8" IPS	235	7.86	7.609	4.9	693	85.0	–	150.0
PE4710	12" DIPS	100	10.914	11.867	4.9	1700	50.0	50	100.0
PVC	12" IPS	160	12.594	11.669	4.9	1655	70.9	–	89.1
PVC	12" IPS	160	12.594	11.669	5.1	1700	72.8	–	87.2
PVC	12" IPS	160	12.594	11.669	4.2	1401	60	–	100.0

WL PLASTICS
An INEOS Business

Manufacturing locations

Bowie, TX
Casper, WY
Cedar City, UT
Elizabethtown, KY
Lubbock, TX (HDPE)
Lubbock, TX (MDPE)
Rapid City, SD
Snyder, TX
Statesboro, GA
Titusville, PA (HDPE/MDPE)

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