



Polyethylene Piping for Underground Fire Main Systems



Bulletin: PP 504

Factory Mutual Approvals
DRISCOPLEX® Polyethylene Piping
for Underground Fire Main Systems

August 2007

Factory Mutual Approvals DRISCOPLEX® Polyethylene Piping for Underground Fire Main Systems

Performance Pipe

PERFORMANCE PIPE is the functional successor to the operations of Plexco¹ and Driscopipe². On July 1, 2000, Chevron Corporation and Phillips Petroleum Company announced the combination of their worldwide chemicals businesses into a new entity, Chevron Phillips Chemical Company LP. Performance Pipe, a division of Chevron Phillips Chemical Company LP, succeeds Plexco and Driscopipe as North America's largest producer of polyethylene piping products for gas, industrial, municipal, mining, oilfield, and utility applications.

Performance Pipe offers more than forty years of polyethylene piping system experience, with pipe and fitting manufacturing facilities throughout the United States.

To enhance the outstanding quality and performance of Performance Pipe polyethylene piping, Chevron Phillips Chemical Company LP further strengthens Performance Pipe with over four decades of quality polyolefin resin production.

A Commitment to Quality and Performance

DriscoPlex® Factory Mutual approved polyethylene piping products for underground firewater service provide high quality, high performance and durability to protect the environment, minimize costs, reduce maintenance and provide long-term, trouble-free service. DriscoPlex® Factory Mutual piping products are manufactured from engineered polyethylene materials that provide a balance of properties for strength, toughness, flexibility, wear resistance, chemical resistance and durability. DriscoPlex® Factory Mutual products maintain excellent long-term hydraulic flow characteristics even at high flow velocities. DriscoPlex® Factory Mutual products are resilient for outstanding tolerance to pressure surge and water hammer. DriscoPlex® Factory Mutual piping products are joined by butt fusion and mechanical methods; however the preferred joining method is butt fusion. Properly made butt fusion joints provide leak-tight, fully restrained connections that are as strong as the pipe itself.

Why Use Polyethylene for Underground Fire Main?

Factory Mutual polyethylene piping has been used for underground fire mains for over 25 years in industrial and municipal firewater systems at refineries, chemical plants and manufacturing plants. Polyethylene piping has unique properties that make it the material of choice for firewater protection of company assets.

¹ Formerly - Plexco, a Division of Chevron Chemical Company

² Formerly - Phillips Driscopipe, A Division of Phillips Petroleum Company

NOTICE - This publication is intended for use as a guide to support the designer of piping systems. It is not intended to be used as installation instructions, and should not be used in place of the advice of a professional engineer. It does not constitute a guarantee or warranty for piping installations. Performance Pipe has made every reasonable effort to ensure the accuracy of this publication, but it may not provide all necessary information, particularly with respect to special or unusual applications. This publication may be changed from time to time without notice. Contact Performance Pipe to determine if you have the most current edition.



Benefits of DRISCOPEX[®] FM Piping Products:

- Complete systems of DriscoPlex[®] Factory Mutual polyethylene pipe, fittings and joining.
- High strength and stiffness to withstand internal pressure and external loads.
- Chemical resistance to withstand corrosive chemicals (pH from 1 to 14) and aggressive soils.
- Toughness, light weight and impact resistance for lower-cost installation and narrower trenches for reduced excavation.
- Cold bending flexibility to follow "lay of the land" contours and reduce the need for directional fittings.
- A hydraulically smooth, non-wetting pipe bore that retains low flow resistance characteristics for the life of the system.
- Does not rust, rot, corrode or tuberculate.
- Non-conductive, cathodic protection NOT required, immune to stray ground currents for minimum long-term maintenance.
- Long-term, low resistance to fluid flow for reduced pumping and operating costs.
- Resistance to environmental stress cracking for long-term performance in harsh environments.
- A fully restrained system without external tie rods or restraints. Butt fusion, flanged and mechanical joint adapter joints are fully restrained to eliminate the need for thrust blocks and external joint restraints.
- Resilience to resist surge and water hammer.

Factory Mutual Approvals - A True Third-Party Certification

Performance Pipe DriscoPlex® Factory Mutual Piping Systems are a unique union of high performing engineered polyethylene materials, carefully controlled manufacturing processes and quality assurance. Performance Pipe manufacturing facilities and DriscoPlex® Factory Mutual piping products and have been tested, evaluated and approved by Factory Mutual Approvals. Manufacturing facilities are regularly inspected to insure compliance with Factory Mutual Approvals standards.

- Factory Mutual products can be manufactured only in facilities that are inspected and approved by Factory Mutual Approvals. Performance Pipe has multiple FMA Approved facilities to serve you.
- Each Factory Mutual product is evaluated and tested by Factory Mutual Approvals Guidelines and Specifications before they are approved and listed.
- DriscoPlex® Factory Mutual products from Performance Pipe are unique and different from our standard product lines because of the special product and certification requirements imposed by Factory Mutual Approvals.

DriscoPlex® Factory Mutual Piping Product Lines

DRISCOPEX® Factory Mutual Piping Product	Typical Features	Previous Designations	
		Former Plexco Product	Former Driscopipe Product
DRISCOPEX® 1500	1, 2, 5, 6, 7	REDSTRIPE, BLUESTRIPE -FM	1000 FM
DRISCOPEX® 1600	3, 4, 5, 6, 7	–	–

NOTICE. Capabilities vary from manufacturing plant to manufacturing plant. Contact Performance Pipe to determine the availability of specific products and the availability of particular stripe colors, striping patterns, and IPS or DIPS sizing.

Legend for Typical Features :

1. IPS sizing system.	3. DIPS sizing system.	5. Red stripe color standard.
2. The standard IPS longitudinal color stripe pattern is four equally spaced single color stripes extruded into the pipe OD.	4. The standard DIPS longitudinal color stripe pattern is three equally spaced pairs of color stripes extruded into the pipe OD.	6. Blue stripe color for dual marked FMA/AWWA.
		7. Optional black pipe without stripe available.

Class Ratings

DriscoPlex® Factory Mutual piping products are produced in Class 150 and Class 200 service pressure ratings. Service pressure ratings are subject to elevated temperatures and pressure surges caused by sudden flow velocity changes. Embedment soil contamination such as hydrocarbon saturation may also affect service pressure ratings.

Class Ratings

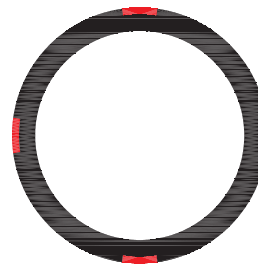
Class	Continuous Service Pressure, psi (MPa) at Continuous Service Temperature, °F (°C)			
	73°F (23°C)	100°F (38°C)	120°F (49°C)	140°F (60°C)
Class 150	150 (1.03)	125 (0.86)	100 (0.69)	80 (0.55)
Class 200	200 (1.38)	156 (1.08)	126 (0.87)	100 (0.69)

Pressure ratings are for water service under steady pressure, temperature and flow. Class rating may be reduced by pressure surge. See "Pressure Surge" and "Surge Allowance" below. Where embedment soils contain significant levels of solvating chemicals such as hydrocarbons, a significant pressure rating reduction may be necessary.

Red Stripes for Firewater Service

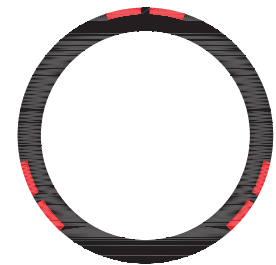
DriscoPlex® 1500 and DriscoPlex® 1600 piping systems are manufactured with longitudinal red stripes that are permanently extruded into the pipe OD. DriscoPlex® 1500 IPS sized pipe has four red stripes equally spaced around the pipe. DriscoPlex® 1600 DIPS sized pipe has three equally spaced pairs of red stripes extruded into the pipe OD. No matter how the pipe is turned, red stripes are always visible. When excavated, the red stripes immediately identify firewater service.

**DRISCOPLEX®
1500**



IPS - Four equally spaced stripes extruded into the pipe wall

**DRISCOPLEX®
1600**



DIPS - Three equally spaced pairs of stripes extruded into the pipe wall

Blue stripes available upon request

Dual Marked FMA/AWWA - Two Needs - One System



When a common main provides firewater and potable water, Performance Pipe has the answer - Dual marking FMA and AWWA - certified by Factory Mutual Approvals for underground fire main and manufactured to AWWA Standards for potable water. Dual FMA/AWWA manufactured products are identified by longitudinal blue stripes extruded into the pipe OD.

Materials

DriscoPlex® Factory Mutual pipe and fittings are manufactured from high-density, extra high molecular weight polyethylene piping compounds. These piping compounds are stress rated PE 3608 (3408) materials in accordance with ASTM D 2837 and PPI-Listed in accordance with PPI TR-3. In accordance with ASTM D 3350, the cell classification is 345464C.

DriscoPlex® Factory Mutual Pipe Sizes

DRISCOPLEX® 1500 IPS Sized Pipe (the same OD as 2" IPS through 24" IPS steel pipe)

Size	OD, in	Class 150		Class 200	
		Average ID, in	Approx wt per ft, lbs	Average ID, in	Approx wt per ft, lbs
2	2.375	1.92	0.64	1.82	0.76
3	3.500	2.83	1.39	2.68	1.66
4	4.500	3.63	2.29	3.44	2.74
6	6.625	5.35	4.97	5.07	5.93
8	8.625	6.96	8.42	6.59	10.05
10	10.750	8.68	13.09	8.22	15.61
12	12.750	10.29	18.41	9.75	21.97
14	14.000	11.30	22.20	10.70	26.50
16	16.000	12.92	29.00	12.23	34.60
18	18.000	14.53	36.69	13.76	43.79
20	20.000	16.15	45.30	15.29	54.05
22	22.000	17.76	54.82	16.82	65.40
24	24.000	19.37	65.24	18.35	77.85

Average ID for flow calculations. Actual ID will vary. Pipe weights calculated in accordance with PPI TR-7.

DRISCOPLEX® 1600 DIPS Sized Pipe (the same OD as 4" through 24" cast or ductile iron pipe)

Size	OD, in	Class 150		Class 200	
		Average ID, in	Approx wt per ft, lbs	Average ID, in	Approx wt per ft, lbs
4	4.80	3.88	2.61	3.67	3.11
6	6.90	5.57	5.39	5.27	6.44
8	9.05	7.31	9.28	6.92	11.07
10	11.10	8.96	13.95	8.49	16.65
12	13.20	10.66	19.73	10.09	23.55
14	15.30	12.35	26.51	11.70	31.64
16	17.40	14.05	34.29	13.30	40.91
18	19.50	15.74	43.07	14.91	51.40
20	21.60	17.44	52.85	16.51	63.05
24	25.80	20.83	75.38	19.72	89.97

Average ID for flow calculations. Actual ID will vary. Pipe weights calculated in accordance with PPI TR-7.



<i>Fitting</i>	<i>Sizing System</i>	<i>Class</i>	<i>Fusion Outlet "a" Size</i>	<i>Pressure Rating, psi (MPa)</i>
Molded 45° & 90° Elbow Outlets - a x a	IPS	150	2, 3, 4, 6, 8	150 (1.03)
	IPS	200	2, 3, 4, 6, 8	200 (1.38)
Molded Tee Outlets - a x a x a	IPS	150	2, 3, 4, 6, 8	150 (1.03)
	IPS	200	2, 3, 4, 6, 8	200 (1.38)
End Cap, Outlet - a	IPS	150	2, 3, 4, 6, 8	150 (1.03)
	IPS	200	2, 3, 4, 6, 8	200 (1.38)
Reducer, Outlets - a x b	IPS	150	3 x 2, 4 x 2, 4 x 3, 6 x 4, 8 x 6	150 (1.03)
	IPS	200	3 x 2, 4 x 2, 4 x 3, 6 x 4, 8 x 6	200 (1.38)
MJ (DIPS) x fusion (IPS) MJ Adapter	150	4 x 4, 6 x 6, 8 x 8, 10 x 10, 12 x 12		150 (1.03)
	200	4 x 4, 6 x 6, 8 x 8, 10 x 10, 12 x 12		200 (1.38)
MJ (DIPS) x fusion (DIPS) MJ Adapter	150	4 x 4, 6 x 6, 8 x 8, 10 x 10, 12 x 12		150 (1.03)
	200	4 x 4, 6 x 6, 8 x 8, 10 x 10		200 (1.38)



<i>Fitting</i>	<i>Outlet Sizing System</i>	<i>Class</i>	<i>Sizes</i>	<i>Pressure Rating, psi (MPa)</i>
Flange Adapter	IPS	150	2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24	150 (1.03)
	IPS	200	2, 3, 4, 6, 8, 10, 12, 14, 16	200 (1.38)
	DIPS	150	4, 6, 8, 10, 12, 14	150 (1.03)

General Design Guidelines for Underground Firewater Systems

Information on polyethylene piping system design is available in *The Plastics Pipe Institute Handbook of Polyethylene Pipe*. Copies are available on the Plastics Pipe Institute's website; www.plasticpipe.org.

Water Flow

DriscoPlex® Factory Mutual polyethylene pipe has a hydraulically smooth, non-wetting surface that resists scale, slime and sediment deposits, and does not rust, rot corrode or tuberculate. Because polyethylene pipe flow characteristics do not deteriorate over time like metallic piping, design flows are maintained and long-term pumping costs are minimized. Pressure water flow in polyethylene pipe may be described by the Hazen-Williams equation.

$$p_f = \frac{0.0009015 L}{d^{4.8655}} \left(\frac{100 Q}{C} \right)^{1.85}$$

Where:

p_f	=	friction (head) loss for water, lb/in ²
L	=	pipeline length, ft
d	=	pipe ID, in
Q	=	flow, U.S. gal/min
C	=	Hazen-Williams roughness coefficient

A Hazen-Williams roughness coefficient, C, of 150 is generally used for a conservative design basis.

Pressure Surge (Water Hammer)

Pressure surge (water hammer) in a liquid piping system is a high velocity pressure wave caused by a sudden change in liquid flow velocity. A sudden valve opening or closing, a piping failure, or a pump starting or stopping can cause an instantaneous change in flow velocity. The sudden liquid velocity change causes a momentum change resulting in a pressure surge. The pressure surge is superimposed on the system as a pressure wave, and may be negative or positive. Compressible fluids (gases) are not subject to pressure surge.

Surge Allowance

DriscoPlex® Factory Mutual polyethylene pipe has excellent resilience, flexibility and short-term mechanical strength that provide exceptional surge tolerance. A low elastic modulus provides a dampening mechanism for shock loads. These properties result in lower surge pressures compared to more rigid systems such as steel, ductile iron or PVC. For the same velocity change in water piping systems, surge pressures in DriscoPlex® Factory Mutual polyethylene pipe are about 86% less than in steel pipe, about 80% less than in ductile iron pipe and about 50% less than in PVC pipe.

Surges affect systems differently depending upon the system design, the magnitude of the surge pressure and surge frequency. Water systems may be subject to positive or negative surge pressures when there is a sudden increase or decrease in flow velocity. Surge pressure corresponds directly to velocity change, that is, greater velocity change produces greater surge pressure. In general, there are two types of pressure surges, recurrent and occasional.

- Recurrent pressure surges are repetitive surge events that occur frequently such as cyclical pump start-stop operation.
- Occasional pressure surges are irregularly occurring surges such as a sudden flow change due to firefighting or check valve operation.

With its unique ductile elastic properties and superb fatigue resistance, Performance Pipe polyethylene pipe is especially tolerant of pressure surges. Surge Allowance pressure is applied above the Class Rating pressure.

Surge Allowance†

FMA Class	Class Rating, psi	Recurring Surge Events		Occasional Surge Events	
		Surge Allowance Pressure, P_{RS} , psi	Corresponding Sudden Velocity Change, fps	Surge Allowance Pressure, P_{OS} , psi	Corresponding Sudden Velocity Change, fps
150	150	90	6.3	170	11.9
200	200	100	6.2	200	12.4

† Pressure and velocity ratings are for water at 80°F (27°C) or less, and can vary for other fluids and temperatures.

Surge allowance pressure is only for surge events. It should never be applied to continuous pressure. If the potential for surge pressure is less than the surge pressure allowance, the excess surge pressure allowance is never used to increase Class Rating pressure. Allowable surge pressure may be limited by the pressure ratings of pumps, valves, fittings, partially restrained or non-restrained connections, or other appurtenances.

There are three basic internal pressure conditions for the pipe: **(a)** when there is no potential for surge pressure, **(b)** when there is a potential for surge that is within the surge pressure allowance, and **(c)** when the potential for surge pressure exceeds the surge pressure allowance. Under all conditions, the continuous pressure in the pipe is never greater than the Class Rating of the pipe.

(a) Under the first condition, no surge allowance is necessary, so the maximum allowable pressure in the pipe is the Class Rating pressure (i.e. class 150 or class 200).

(b) Under the second condition, and

- When recurrent surge occurs, the Recurrent Surge Allowance Pressure, P_{RS} , is applied above the Class Rating. During surge, the maximum allowable pressure in the pipe is the Class Rating Pressure plus P_{RS} . During non-surge times, the maximum allowable pressure in the pipe is the Class Rating pressure.
- When occasional surge occurs, the Occasional Surge Allowance Pressure, P_{OS} , is applied above the Class Rating. During surge, the maximum allowable pressure in the pipe is the Class Rating Pressure plus P_{OS} . During non-surge times, the maximum allowable pressure in the pipe is the Class Rating pressure.

- The maximum allowable continuous pressure in the pipe is the Class Rating Pressure.

(c) The third condition is when a sudden velocity change will exceed the corresponding velocity change value in the Surge Allowance table. This will cause a surge pressure that will exceed the surge pressure allowance. To compensate for higher velocity and surge pressure, the Class Rating pressure of the pipe must be reduced.

Joining

Joining methods for DriscoPlex[®] Factory Mutual polyethylene pipe and fittings are butt fusion or mechanical joints using DriscoPlex[®] Factory Mutual flange adapters or DriscoPlex[®] Factory Mutual MJ adapters. These joining methods are Factory Mutual approved for DriscoPlex[®] Factory Mutual pipe and fittings and produce fully restrained joints. *Bulletin: PP 750 Performance Pipe Heat Fusion Joining Procedures, Flange Joining Procedures and MJ Adapter Joining Procedures* are available from your Performance Pipe Distributor or Territory Manager.

Poisson Effects

When DriscoPlex[®] Factory Mutual polyethylene piping is connected to an existing firewater piping system; the transition connection must be fully restrained using DriscoPlex[®] Factory Mutual flange adapters or DriscoPlex[®] Factory Mutual MJ adapters. *Joining methods that do not provide pullout restraint should not be used in a DriscoPlex[®] Factory Mutual polyethylene piping system.*

When a tensile stress is applied along one dimension, all materials will lengthen in the direction of the applied stress, and its other dimensions will decrease. The ratio of decrease to increase is the Poisson ratio. For polyethylene piping, the Poisson ratio is 0.45 for long-term tensile stress and 0.35 for short-term tensile stress. Therefore, when polyethylene pipe is pressurized, the pipe will expand slightly in diameter and the length will shorten slightly.

DriscoPlex[®] Factory Mutual piping is a fully restrained system. When long straight pipe lengths are pressurized, the Poisson effect will cause the length to shorten slightly. Although the overall length reduction is slight, the cumulative effect for a long length may be enough to cause pull-out of an unrestrained joint that is in-line with the long length. Anchoring the pipe in the ground can effectively control Poisson effect shortening. Directional fittings such as tees and elbows, DriscoPlex[®] Factory Mutual flange or MJ connections to appurtenances such as valves and hydrants, and in-line anchor rings are effective.

Conventional thrust blocks are not effective because they are designed to restrain fitting movement, not pipe movement. When the flow direction changes, a thrust force develops in the fitting and tries to move it away from the pipe. But the Poisson effect moves the pipe away from the fitting. Therefore, thrust blocks that restrain fitting movement are not effective in controlling Poisson effects that can cause pipe movement.

Where DriscoPlex[®] Factory Mutual pipe transitions to existing firewater piping; unrestrained joints in existing firewater piping may be affected if the unrestrained joints are in-line with the polyethylene pipe. The transition connection is fully restrained, thus Poisson effects may transfer and may cause disjoining of in-line bell and spigot joints in the existing firewater piping. In such cases, external restraints should be added to a number of bell and spigot joints that are in-line with the pipe run, or the polyethylene pipe at the transition connection should be anchored.

Joint Restraints and Thrust Blocks

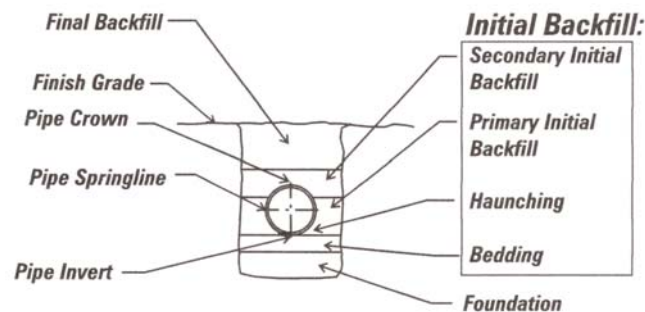
DriscoPlex® butt fusion, flange and MJ adapter connections are fully restrained without external joint restraints. Thrust blocks are not required; however, if thrust blocks are installed at fittings, the thrust block must fully encapsulate the fitting. Conventional thrust block constructions that bear against part of the fitting surface can result in impingement loads that can cause premature failure.

Installation

DriscoPlex® Factory Mutual piping products are Factory Mutual Approved for underground installation only. DriscoPlex® Factory Mutual piping products are not intended or certified for use within structures or for sprinkler systems.

DriscoPlex® Factory Mutual piping should be installed underground in accordance with the *Performance Pipe Engineering Manual* and the latest published edition of *ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping*³.

DriscoPlex® Factory Mutual pipe may be cold bent in the field to a minimum bend radius of 25 times the pipe diameter. Where fittings, valves or appurtenances, or flange or MJ adapter connections are present in the bend, the minimum bend radius is 100 times the pipe diameter.



Nominal Pipe OD, in	Minimum Trench Width, in	Clearance Between Parallel Pipes, in
2 – 3	12	4
> 3 – 16	Pipe OD + 12	6
> 16 – 24	Pipe OD + 18	9

DriscoPlex® Factory Mutual piping must be completely encapsulated in compacted embedment in the haunch and initial backfill areas. For smaller pipe sizes, secondary initial backfill should extend approximately 12" (0.3 m) above the pipe crown, and should extend approximately one pipe diameter above the pipe crown for sizes above 12". Preferred embedment materials for haunch and initial backfill are angular crushed stone and coarse sands and gravels⁴. Particle sizes for materials in contact with the pipe should not exceed ½" (13 mm) for pipes 4" and smaller, ¾" for 6" to 8" pipes, 1" for 10" to 16" pipes, and 1 ¼" for larger pipes. Uniformly graded materials are more easily placed and compacted; however, materials containing fines are acceptable. Embedment materials should be carefully placed in layers and each layer compacted. Ensure that haunch areas are completely filled and that there are no voids below the pipe. When backfilling, all temporary pipe blocking and supports must be removed. In suitable soils, the construction of bedding or foundation for the pipe may not be required. Appropriate native soils may be used for final backfill to finish grade. Foundation, bedding and backfill for valves, hydrants and appurtenances should be installed in accordance with manufacturer's recommendations.

Leak Testing

Conduct hydrostatic leak tests in accordance with *Performance Pipe Technical Note PP-802 Leak Testing*. Copies are available from your Performance Pipe Distributor or Territory Manager. Pneumatic leak testing is not recommended.

WARNING - Death or serious injury can result from failure at a joint or connection during pressure leak testing. Keep all persons a safe distance away during testing. The test section is to be supervised at all times during the test.

Ensure that all piping is restrained against possible movement from catastrophic failure at a joint or connection. When pressurized, faulty joint or connections may separate suddenly causing violent and dangerous movement of piping or parts. Correctly made joints do not leak. Leakage at a joint or connection may immediately precede catastrophic failure. Never approach or attempt to repair or stop leaks while the test section is pressurized. Always depressurize the test section before making repairs.

The maximum test pressure is the lower of

- The pressure rating of the lowest pressure rated valve, hydrant, appurtenance or other system component in the test section, or
- 1.5 times the Class Rating pressure of the pipe at the lowest point in the test section.

For DriscoPlex® Factory Mutual pipe, the maximum test pressures at 73°F are 225 psi for Class 150 pipe and 300 psi for Class 200 pipe. Test pressure is reduced at elevated temperatures.

ASTM D 3350 Cell Classification Descriptions

D 3350 Cell Classification Number	Property, ASTM Standard, units	Range of Typical Values Allowed per D 3350 Cell Classification Number	Typical Value for HDPE Material
3	Density, D 1505, gm/cm ³	0.941 – 0.955*	0.955 ±0.946§
4	Melt Index, D 1238, gm/10 min	<0.15	0.08
5	Flexural Modulus, D 790, psi 2% Secant -16:1 Span; depth, 0.5 in/min	110,000 – 160,000	>110,000
4	Tensile Strength at Yield, D 638, psi	3,000 – 3,500	3,200
6	F 1473 (PENT), hours	>100	>100
4	Hydrostatic Design Basis, D 2837, psi	1600	1600
C, E	Color & UV Stabilizer, D 3350	C = Min 2% carbon black; E = Color with UV Stabilizer	C = 2-3% carbon Black E = Color with UV Stabilizer

⌘NOTICE – This chart provides typical physical property information for polyethylene resins used to manufacture Performance Pipe polyethylene piping products. It is intended for comparing polyethylene piping resins. It is not a product specification, and it does not establish minimum or maximum values or manufacturing tolerances for resins or for piping products. These typical physical property values were determined using compression-molded plaques prepared from resin. Values obtained from tests of specimens taken from piping products can vary from these typical values. Performance Pipe has made every reasonable effort to ensure the accuracy of this chart, but this chart may not provide all necessary information, particularly with respect to special or unusual applications. * Base resin - unpigmented. ±Black = 0.944 g/cc nominal resin density + 0.011 g/cc for 2.5% carbon black. § Non-black or color = 0.944 g/cc nominal resin density + 0.002 g/cc for color and UV stabilizer.

CONTACT INFORMATION:

PERFORMANCE PIPE, a division of Chevron Phillips Chemical Company LP

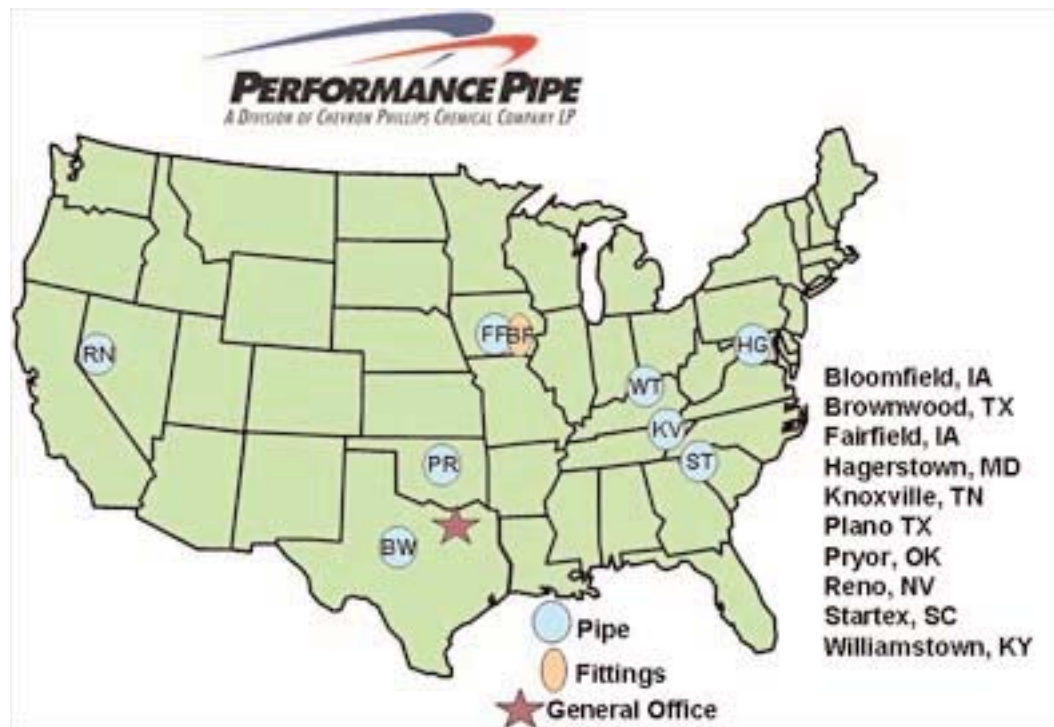
PO Box 269006
Plano, TX 75026-9006

To secure product information
or technical assistance:

Phone: 800-527-0662
Fax: 972-599-7348

Visit us at www.performancepipe.com for the latest complete literature.

Performance Pipe Strategically Located Plants:



participating member  PLASTICS PIPE INSTITUTE™