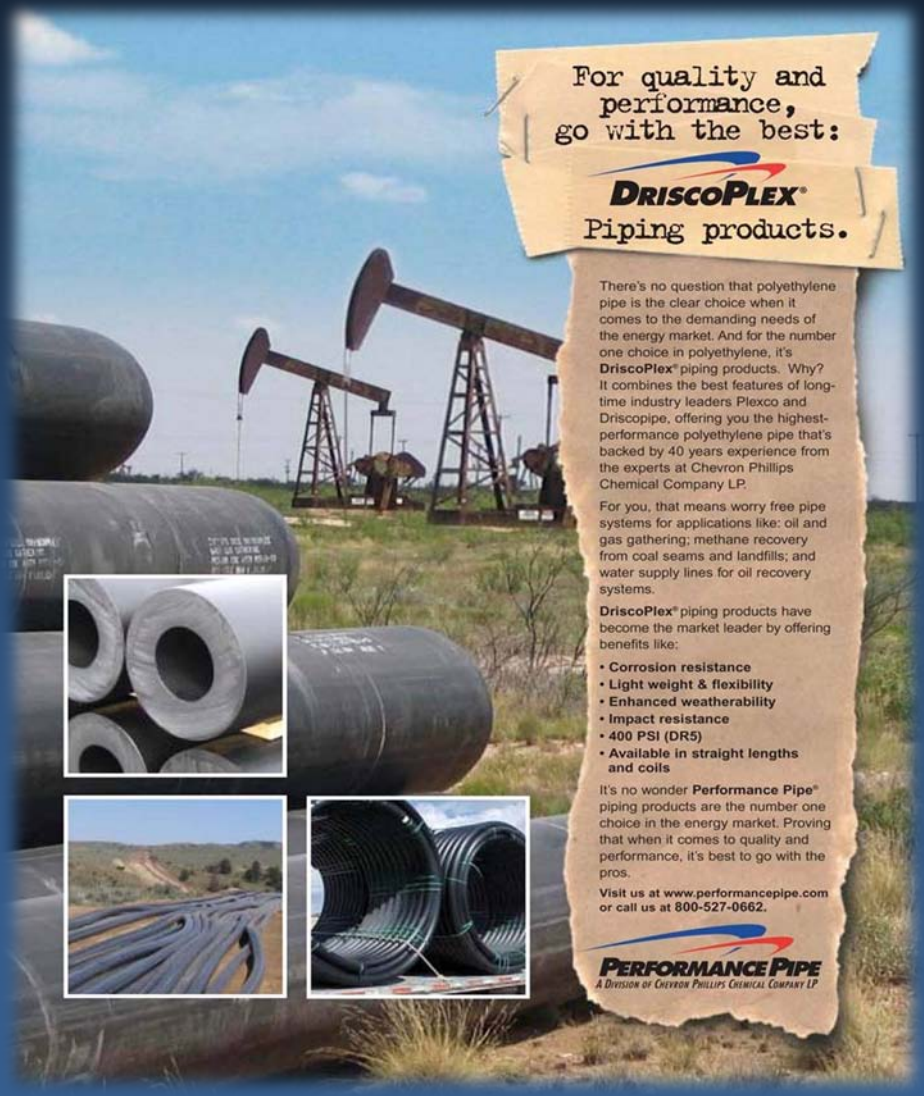
PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

PERFORMANCE PIPE DRISCOPLEX® 6400 SERIES

Oil, Gas Gathering & Energy Piping Systems

- Oil and Gas Gathering
- Produced Water
- Brine & Salt Water Service
- Crude Oil Collection and Transportation
- Coal Bed Methane
- Shale Methane Recovery
- Shale Hydraulic Fracturing
- Sour Service CO_2 and H_2S
- Liners
- Landfill Methane Recovery
- Leachate Collection
- Raw Water Lines



Performance Pipe

Performance Pipe is a name you can trust in energy application piping. We produce our Driscoplex 6400 series products for use in crude oil collection & transportation, gas gathering, landfill methane, leachate collection systems, brine & raw water and most all oil field piping energy applications. These include Shale Methane Recovery, Shale Hydrofracturing and CO_2 Enhanced Coal Bed Methane (ECBM).

Performance Pipe has nine ISO 9001 certified manufacturing facilities strategically located across the United States and more than fifty years of polyethylene pipe manufacturing experience.

When you select Performance Pipe Driscoplex® 6400 series pipe and fittings, in addition to receiving quality products, you also gain access to our team of experts for technical support, sales and assistance. Our territory sales teams are dedicated to the energy industry and are active members of the American Petroleum Institute, American Gas Association, ASTM International, Plastics Pipe Institute and many other industry associations. As a company we provide technical expertise and service to these organizations on an ongoing basis.

The unmatched quality and performance of Performance Pipe's polyethylene piping products is further enhanced and strengthened by more than five decades of quality polyolefin plastic resin production from our parent company Chevron Phillips Chemical Company LP.

Pipe

Performance Pipe's Driscoplex® 6400 series piping products are produced to meet or exceed the manufacturing and material requirements of the latest edition of ASTM D2513 *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*. The pipes also meet all applicable requirements of API 15LE *"Specification for Polyethylene Line Pipe (PE)".*

Fittings

Performance Pipe manufactures a full range of HDPE *Fittings* for butt, socket, and saddle fusion in sizes through 8" diameter. Flange Connections are available through 18 inch diameter. Larger size fittings are available from fittings manufacturers.

Quality

Performance Pipe's polyethylene piping products for are unmatched in quality and performance. They are produced to the requirements of ASTM D2513 "*Standard Specification for Polyethylene (PE) as Pressure Pipe, Tubing and Fittings"*.

Our internal QA/QC requirements meet or exceed those required by industry standards. Each product line is continuously monitored throughout the manufacturing cycle to ensure that the product adheres to all internal quality control specifications and the manufacturing standard.

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All nine of Performance Pipe's manufacturing facilities and our headquarters are certified in accordance with the latest edition of *ISO 9001*. Certificates of Conformance are available through our website.

Sizes

Performance Pipe manufactures its Driscoplex® 6400 series product in ¾" through 36" IPS sizes. The pipe is available in forty (40) or fifty (50) foot lengths. Driscoplex® 6400 series is also available in coils through 6" IPS. Packaging and Loading information is available on our website at www.PerformancePipe.com under Oil and Gas Gathering Packaging. Pressure ratings, sizes and weights are also available for each pipe size and DR offered.

Above Ground Service and UV Protection

Driscoplex® 6400 series products are defined as Code C materials in accordance with ASTM D3350 and are suitable for extended outdoor service. The product is protected against outdoor exposure through the addition of a minimum of 2-3 percent carbon black. Accelerated laboratory weathering tests conducted on formulations of carbon black enhanced polyethylene materials, indicated that finely dispersed carbon black imparted excellent UV resistance in long term service.

Performance Pipe polyethylene Driscoplex® 6400 piping products are fully protected from UV effects and outdoor exposure to ensure pipe performance requirements are maintained. Surface and above grade applications must be properly supported and must take thermal expansion and contraction into account.

Direct Burial

Like all piping materials, HDPE piping must be properly installed. Driscoplex® 6400 series pipe should be installed in accordance with ASTM D 2774 "*Standard Practice for Underground Installation of Thermoplastic Pressure Piping" and Bulletin PP-901, "Field Handbook"*. HDPE is a flexible piping material that works together with its soil embedment to sustain the earth and live loads above it. Suitable embedment is required to provide support around the pipe, and embedment materials must be placed so that the pipe is properly surrounded. In general, coarse, angular sands and gravels are preferred, but other materials may be used under the direction of the design engineer. See ASTM D2774 for recommended embedment material size.

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Embedment material must be placed in the haunch areas below the pipe springline and above the pipe so that the pipe is fully encapsulated without voids. Compacted embedment is preferred. To ensure protection against shear and bending loads measures, such as properly placed & compacted backfill, protective sleeves, and structural support, are sometimes necessary.

Locating

Most polyethylene materials are not detectable with standard magnetic locating equipment. When installing PE piping, a method or methods for future pipeline detection should be considered. Underground locating agencies should always be contacted before the start of any underground installation work such as excavation, trenching, and directional drilling

Leak Testing

Polyethylene pipe may be hydrostatically tested or pneumatically tested to determine system integrity for leaks. When testing is required, observe all safety measures, especially if using pressurized gas as the test medium. Consideration is given to restraining the pipe against movement in the event of catastrophic failure, observing limitations of temperature, test pressure, test duration, and procedures for making repairs.

Performance Pipe's hydrostatic leak testing procedure "Technical Note 802" is available on the website under Engineering Information. Also see ASTM F2786 "Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing)" for additional guidance.

Joining

Driscoplex® 6400 series pipe and fittings may be joined using Performance Pipe's Bulletin PP-750 *"Heat Fusion Joining Procedures and Qualification Guide".* A copy of PP-750 may be obtained from our website www.PerformancePipe.com under the Fusion heading.

Other joining procedure guidance for butt and saddle fusion of polyethylene piping products is available at ASTM F2620 *"Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings".* ASTM F2620 also provides guidance on visual field quality assurance tests. Data Loggers for fusion equipment are also available to provide additional quality assurance.

ASTM F2620 also provides guidance for conducting bendback destructive testing for pipes with wall thicknesses <1inch thick. Pipes with a wall thickness ≥ 1inch require special considerations for destructive testing and the fusion equipment manufacturer or Performance Pipe should be consulted if destructive testing is required.

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Performance Characteristics

Polyethylene Resins Continue to Improve

DriscoPlex® 6400 series pipe and fittings for oilfield and energy applications are made from polyethylene materials that are engineered for high density, extra high molecular weight, and broad molecular weight distribution. These characteristics give Driscoplex® 6400 series products strength, flexibility, toughness and durability. Since the introduction of polyethylene piping materials in the 1950's, polyethylene resin manufacturers have continually improved the resins produced. In 2005 "High Performance" polyethylene pipe materials were adopted in U.S. ASTM standards. One of the new material designation codes refer to PE4710. Compared to PE3408 (now PE3608) materials, the PE4710 resins have an increased density, higher tensile strength and higher resistance to slow crack growth. These increased properties allow the pipe to meet higher performance requirements.

Performance Pipe now manufactures all pipe and fittings of high performance PE4710 resins. Performance Pipe's PE4710 materials are listed in PPI TR-4 with a Hydrostatic Design Stress of 1000 psi at 73°F.

PE4710 materials are an improvement in resin properties and exceed the proven good long term performance of PE2708, PE3408, PE3608, PE3710 or PE4708 pipe and fittings. PE4710 pipes meet and exceed the physical and performance properties of all the previous material designation codes between PE3408 and PE4710.

API 15LE "Specification for Polyethylene Line Pipe (PE)" recognizes the higher performing PE4710 materials and allows higher operating pressures as compared to PE3408 materials. Refer to API 15LE 4th Edition 2008.

Cell Classification

ASTM D3350 "*Standard Specification for Polyethylene Plastics Pipe and Fittings Materials" provides a* cell classification system that covers the identification of polyethylene materials for pipe and fittings. Performance Pipe's Driscoplex® 6400 series cell classification is listed.

Table 1: Cell Classification

Performance Pipe Product Series	Material Designation Code (MDC)		ASTM D3350 Cell Classification
	Present	Past	
DRISCOPIPE® 6400 HDPE	PE4710	(PE3408)	445574C

Slow Crack Growth (SCG) Resistance

Resistance to slow crack growth is a critical performance requirement because long-term stress can cause cracks to grow slowly through polyethylene pipe resin material. Resistance to slow crack growth is measured using ASTM F1473 "*Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins"*. Driscoplex® 6400 series products exceed the requirements of ASTM D2513 that requires that all PE materials meet a minimum of at least 100 hours for two tests before failure when tested per ASTM F1473.

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Table 2: Typical PENT Value

Performance Pipe Product Series	PENT, hours (ASTM F1473)
DRISCOPIPE® 6400 HDPE (PE4710/3408)	>500

Permeability and Permeation

Plastics are permeable to gases to varying degrees. Although some constituents of natural gas can permeate through polyethylene, the volume of gas lost through permeation is generally so low as to have an insignificant effect on the handling of natural gas in a piping system.

Other constituents of natural gas are typically heavier than methane, thus less permeable through polyethylene. Hydrogen is the exception; however, the concentration of hydrogen in most natural gas is so low that the actual amount of hydrogen permeation is insignificant. At low temperatures and higher pressures, heavier hydrocarbon gases such as propane or butane may condense and liquefy in the pipe. Such condensates are known to permeate polyethylene pipe.

Liquid hydrocarbon permeation can affect butt fusion joining. Driscoplex® 6400 piping that has been in service conveying liquid hydrocarbons or wet natural gas that includes heavier hydrocarbons can sometimes exhibit a bubbly appearance when re-melted for heat fusion. This bubbling is the result of the rapid expansion (by heat) and passage of heavier, adsorbed hydrocarbon gases through the heated and molten polyethylene material. Since there currently are no field tests to readily determine the amount of adsorbed hydrocarbons in PE pipe and their potential effect on the fusion joint, the heat fusion process should be abandoned and mechanical connections are recommended if bubbles are encountered during a heat fusion process.

Vacuum or Suction Pipelines

Typical cases of vacuum or suction pipelines are gravity flow, downhill siphon lines, pipelines which are cleaned by vacuum and gas gathering lines operating under vacuum. When Driscoplex® 6400 series is used in vacuum applications; a sufficiently heavy wall pipe must be selected to resist the collapsing forces. The amount of vacuum a pipeline can support is a function of its dimension ratio (DR) and other operating conditions. A thicker wall pipe will provide a greater resistance.

Refer to API 15LE “Specification for Polyethylene Line Pipe (PE)” Appendix B or the Plastic Pipe Institute “Handbook of Polyethylene Pipe”, Chapter 11, for more detailed information on vacuum or suction lines.

Chemical Resistance

Driscoplex® 6400 has outstanding chemical and corrosion resistance and will tolerate most downhole corrosion inhibitors, hot soils and sour gas. It has proven use in crude oil service, low-pressure gas operations, acidic or alkaline water service, and brine service. Dry, gaseous hydrocarbons have no adverse effect on expected service life. Liquid hydrocarbons will permeate the wall and reduce

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hydrostatic strength, but normally will not degrade the material. A technical report of chemical resistance for thermoplastic pipes can be found at the Plastic Pipe Institute's website: TR-19/2007 "Chemical Resistance of Thermoplastics Piping Materials".

Temperature

Operating service temperature for Driscoplex® 6400 may be between –30°F and up to 140°F. The system operating temperature will affect the allowable design parameters of DRISCOPLEX 6400 systems. Detailed temperature rating information is provided in the "Design Pressure" section. Driscoplex® 6400 can handle conditions of freezing water much better than traditional metal piping. In the event that water does freeze inside Driscoplex® 6400, the line should be carefully and fully thawed before placing it back in service. To prevent freezing, the line may be insulated and may be heat traced if necessary. Heat tracing equipment should not exceed 120°F (49°C). Exposure to the sun increases operating temperatures, especially during summer months. This may reduce the Design (Working) Pressure capability of the system.

Design Pressure

The following formula given in API 15LE Section 5.1.5 is used to compute the design pressures in Driscoplex® 6400 piping systems for operating temperatures up to but not over 140°F (60°C). For operating temperatures below 73°F (23°C), use 73°F (23°C) Design Pressures.

$$PR = \frac{2 \times HDS \times FSF \times TSF}{(DR - 1)} \qquad \textit{(Equation 1)}$$

Where:
PR=Pressure Rating, psi
HDS=Hydrostatic Design Stress, Table 3
FSF=Fluid Service Factor
TSF=Temperature Service Factor
DR= Dimension Ratio for OD Controlled Pipe

$$DR = \frac{OD}{t} \qquad \textit{(Equation2)}$$

Where:
OD=Outside Diameter
t=Pipe Minimum Wall Thickness, in

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Table 3: Hydrostatic Design Stress

Hydrostatic Design Stress, HDS	
Performance Pipe Product Series	73 °F (23°C) Data
Driscoplex® 6400 Series (PE4710)	1000

Table 4: Fluid Service Factor (Environmental Application Factor)

Fluid Service Factor, FSF	
Service Fluid	**Fluid Service Factor, FSF**
Water, Brine, Dry gas gathering (no associated hydrocarbon liquids)	1.0
Multiphase fluids, wet natural gas and liquid hydrocarbons. Water containing significant quantities of liquid hydrocarbons (> 2%) should be treated as hydrocarbon liquids.	0.5
Gas distribution or transmission piping that is permeated by solvating chemicals such as liquid hydrocarbons or liquefied gas condensate.	0.5

Table 5: Temperature Service Factor

Temperature Service Factor, TSF							
Service Temperature °F(°C)	<80 (27)	<90 (32)	<100 (38)	<110 (43)	<120 (49)	<130 (54)	<140 (60)
	1.00	0.90	0.78	0.75	0.63	0.60	0.50

Operating Pressures (psig)

The following tables provide ***maximum allowable operating pressures (MAOP)*** for PE4710 pipes. PE pipes of the same DR and Material Designation Code but different outside diameters have the same Design (Working) Pressure Ratings.

Pressure ratings are calculated using Equation 1 above. A check should be made to determine if these pressures apply under the state and/or local codes governing the specific application. Use 80°F pressure ratings for operating temperatures below 80°F (27°C).

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Table 6: Pressure Rating versus Temperature (PE4710) Water, Brine & Dry Natural Gas

Design (Working) Pressures for Water, Brine and Dry Natural Gas Gathering service (Class 1, Class 2 and non-Federally Regulated Areas)				
Driscoplex® 6400 Series (PE4710)	Operating Temperature			
	73.4°F	100°F	120°F	140°F
DR				
6.0	400 psig	312 psig	252 psig	200 psig
7.0	333 psig	260 psig	210 psig	167 psig
9.0	250 psig	195 psig	158 psig	125 psig
11.0	200 psig	156 psig	126 psig	100 psig
17.0	125 psig	98 psig	79 psig	63 psig
21.0	100 psig	78 psig	63 psig	50 psig

Table 7: Pressure Rating versus Temperature (PE4710) Liquid Hydrocarbon

Design (Working) Pressures for Crude Oil, Produced Water with > 2% liquid hydrocarbons, Wet Natural Gas & Condensates (Class 1, Class 2 and non-Federally Regulated Areas)				
Driscoplex ® 6400 Series (PE4710)	Operating Temperature			
	73.4°F	100°F	120°F	140°F
DR				
6.0	200psig	156 psig	126 psig	100psig
7.0	167 psig	130 psig	105 psig	83 psig
9.0	125 psig	98 psig	79 psig	63 psig
11.0	100 psig	78 psig	63 psig	50 psig
17.0	63 psig	49 psig	39 psig	31 psig
21.0	50 psig	39 psig	32 psig	25 psig

Pressure Surge Capacity

System pressures due to frequently occurring surges or water hammer events of up to 1-1/2 times the rated system operating pressure are well within the limits of the DRISCOPLEX piping system. System pressures of twice the rated operating pressure can be tolerated occasionally. For moderate flow velocity systems, i.e. 5 ft/sec or less, it is generally unnecessary to include a surge allowance within the pressure rating of the system. For lines operating at higher velocities, the allowance will be reduced.

Cold Bending Radius

The allowable cold bending radius for DRISCOPLEX® 6400 pipe is dependent upon the pipe OD, DR and the presence of fittings in the bend. See Performance Pipe's Technical Note *PP-819-TN Field Bending of DRISCOPLEX® Pipe*. Table 8 provides the cold bend radius that can be used for long term applications.

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Table 8: Allowable Cold Bending Radius

Table 10: Allowable Cold Bending Radius	
Pipe Dimension Ratio	**Allowable Cold Bending Radius**
9 or less	20 times the pipe OD
>9 to 13.5	25 times the pipe OD
13.5 to 21	27 times the pipe OD
26	34 times the pipe OD
32.5	42 times the pipe OD
Fitting or flange present in the bend	**100 times the pipe OD**

Special Considerations for Plowing and Planting

Plowing and planting involve cutting a narrow trench and feeding the pipe into the trench through a shoe or chute fitted just behind the trench cutting equipment. The shoe or chute feeds the pipe into the bottom of the cut. The minimum bend radius of the pipe through the shoe may be tighter than the minimum bend radius of the pipe used for a permanent long-term installation, but it must not be so tight that the pipe kinks.

Table 9 presents the minimum short-term bend ratio for applications such as plowing and planting. The pipe's path through the shoe or chute should be as friction free as practicable to reduce additional outer-fiber tensile stresses. Generally plowing and planting is limited to 12" and smaller pipes.

Table 9: Minimum Short-term Cold Bending Radius

Table 11: Minimum Short-term Cold Bending Radius	
Pipe Dimension Ratio	**Minimum Short-Term bending Radius**
9	10
>9 to 13.5	13
>13.5 to 17	17

Cautions

Polyethylene piping has been safely used in thousands of applications. However, there are general precautions that should be observed when using any product. Performance Pipe recommends the following reading for a more detailed list of cautions and safety features.

1. The Plastic Pipe Institute Handbook of Polyethylene Pipe, Chapter 2, "Inspection, Tests and Safety Considerations" includes safety considerations for polyethylene pipe.
2. The Performance Pipe Field Handbook also provides safety considerations for handling loading and installation.

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3. Fusion

In addition to the safety precautions noted in the fusion literature, note that during the heat fusion process, equipment and products can reach temperatures in excess of 450°F (231°C). Caution should be taken to prevent burns.

Do not bend pipes into alignment against open butt fusion machine clamps. The pipe may spring out and cause injury or damage.

Performance Pipe does not recommend a bend back field test method for any pipes with a wall thickness over 1 inch. If the field test fails, the broken section can be propelled with great force and represents a safety hazard.

4. Static Electricity

High static electricity charges can develop on polyethylene piping products, especially during squeeze-off, when repairing a leak, purging, or making a connection. See Performance Pipe Technical Note *Polyethylene Pipe Squeeze Off;* *PP 801-TN.*

Where a flammable gas atmosphere and static electric charges may be present, observe all company (pipeline operator, utility, contractor, etc.) safety procedures for controlling and discharging static electricity and all requirements for personal protection.

5. Weight, Unloading and Handling

Although polyethylene pipe is not as heavy as some other piping products, significant weight may be involved. Care should be used when handling and working around polyethylene pipe. Improper handling or abuse may cause damage to piping, compromise system quality or cause personal injury. Observe the safe handling instructions provided by the delivery driver. See our website for: *Pipe Loading/Unloading-Truck Driver Safety Video* .

6. Coils

Coiled PE pipe is restrained with strapping to contain the spring-like energy retained within the coil. Cutting or breaking strapping can result in an uncontrolled release. Take all necessary safety precautions and use appropriate equipment. Observe the safe handling instructions provided by the delivery driver and available through the manuals noted above.

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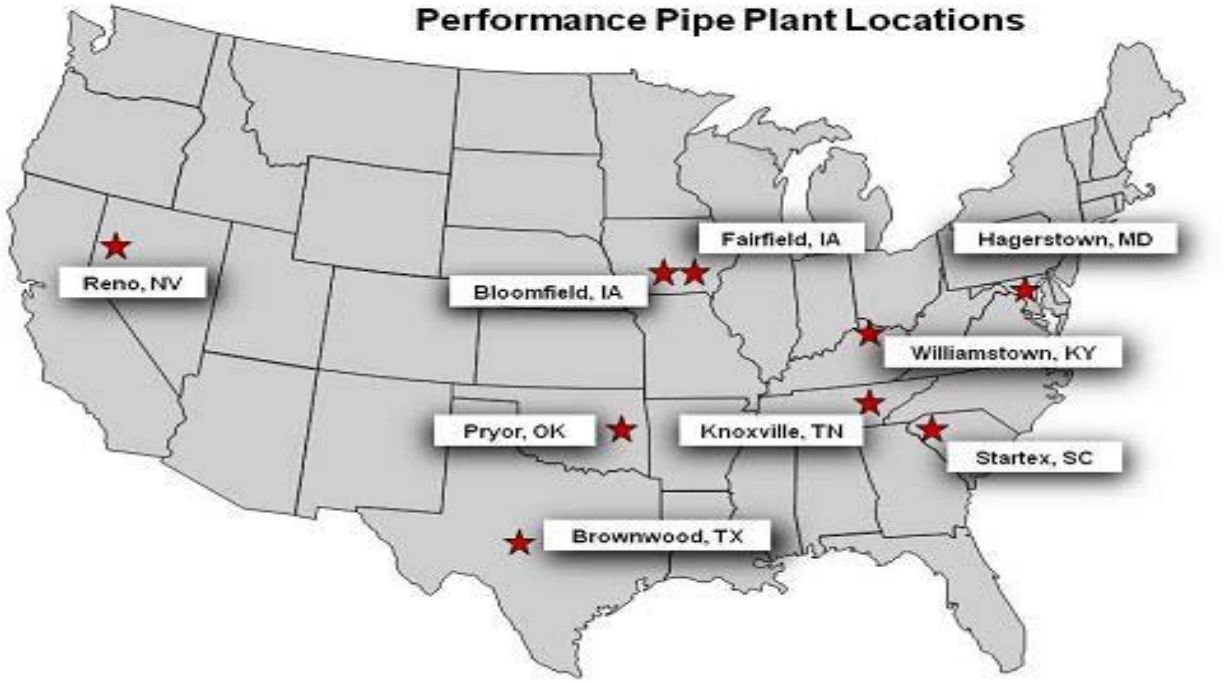
When Performance Matters Rely on Performance Pipe



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