VOLUME IV: POLYETHYLENE

"Pipe-with-the-stripe" PIPING SYSTEMS

MECHANICAL TECHNICAL MANUAL SERIES

POLYETHYLENE PIPING SYSTEMS

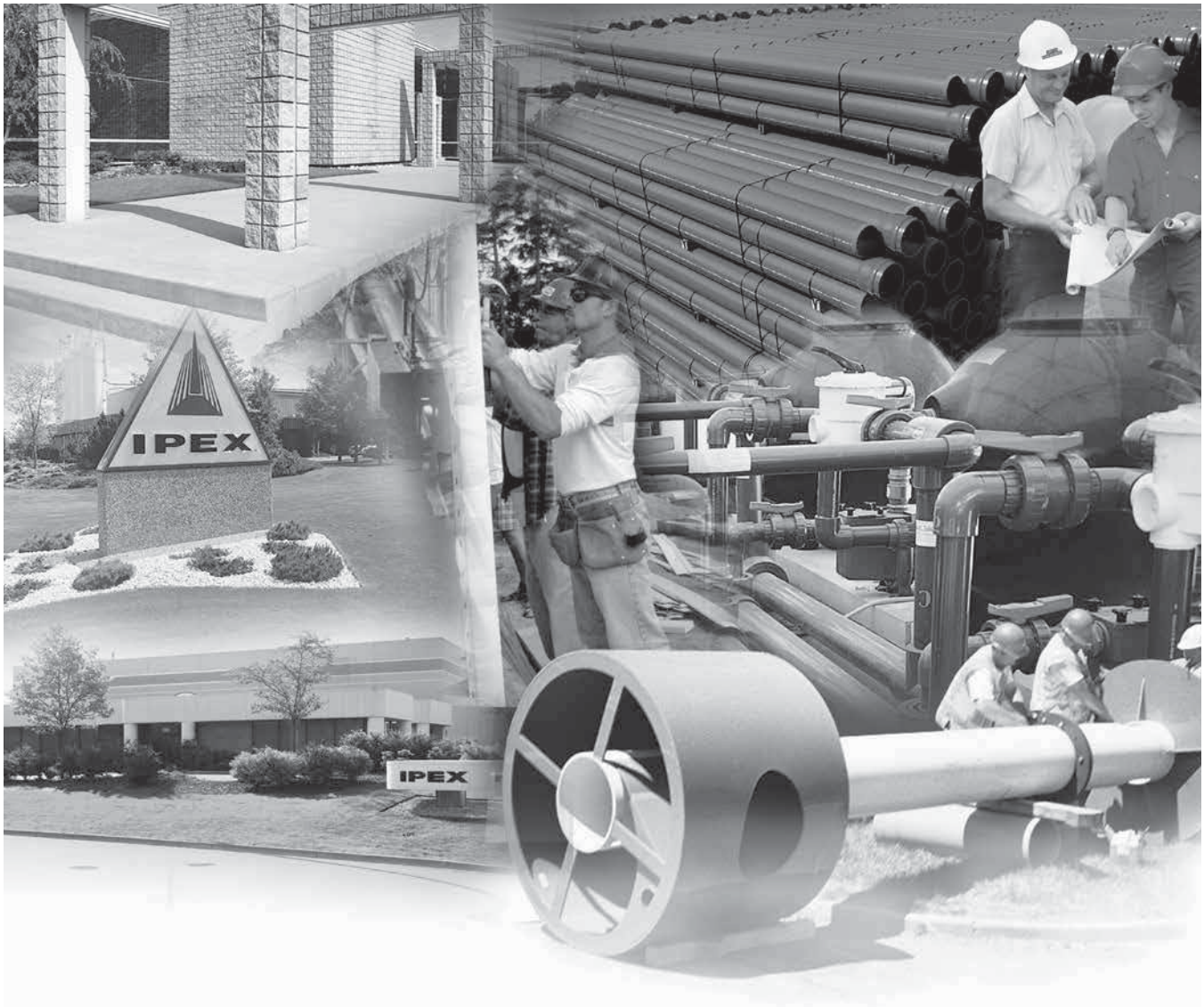
- Water Well Tubing
- Irrigation Systems
- Water Distribution

IPEX by aliaxis

We build tough products for tough environments®

Polyethylene “Pipe with the Stripe” Piping Systems

Mechanical Technical Manual Series, Volume IV



ABOUT IPEX

At IPEX, we have been manufacturing non-metallic pipe and fittings since 1951. We formulate our own compounds and maintain strict quality control during production. Our products are made available for customers thanks to a network of regional stocking locations throughout North America. We offer a wide variety of systems including complete lines of piping, fittings, valves and custom-fabricated items.

More importantly, we are committed to meeting our customers' needs. As a leader in the plastic piping industry, IPEX continually develops new products, modernizes manufacturing facilities and acquires innovative process technology. In addition, our staff take pride in their work, making available to customers their extensive thermoplastic knowledge and field experience. IPEX personnel are committed to improving the safety, reliability and performance of thermoplastic materials. We are involved in several standards committees and are members of and/or comply with the organizations listed on this page.

For specific details about any IPEX product, contact our customer service department.

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Overview

IPEX Inc. is one of the largest manufacturers of plastic piping systems in North America. IPEX manufactures piping systems for many different applications, including plumbing, industrial, sewer and water supply, electrical and telecommunications systems as well as radiant heating systems.

This design manual covers the technical aspects of designing polyethylene piping systems. Pipe with the Stripe® features a permanent coloured stripe identification system. So whether in storage, on the site, or embedded in the ground, Pipe with the Stripe is instantly recognized. This coloured stripe is actually part of the pipe wall and will always remain visible, identifying itself as an IPEX-manufactured pipe.

The manual is organized into two sections:

Section 1 deals with our polyethylene Pipe with the Stripe product and includes detailed information on applications, dimensions and applicable standards.

Section 2 deals with general engineering and design issues associated with polyethylene Pipe with the Stripe.

This manual is designed for Engineers, Technologists and other infrastructure professionals who require a deeper understanding of polyethylene Pipe with the Stripe piping systems than can be gleaned from the more general overview literature available from IPEX.

NOTES

Applications

Durable and flexible Pipe with the Stripe is available in a variety of diameters (see charts on page 9) making it ideal for a wide range of applications:

- Waterwell tubing
- Irrigation systems
- Distribution and transmission of water
- Maple sap collection
- Electrical raceways
- Chemical process lines
- Mine tailing lines
- Ice skating rinks
- Geothermal heating systems

Features & Benefits

Pipe with the Stripe is available in standard and CSA-certified polyethylene. It combines the features of flexibility, durability, light weight and ease of installation. Factors such as life expectancy and economics should be considered in selecting the more suitable material.

Corrosion Proof

Pipe with the Stripe is resistant to decomposition, oxidation, and hostile elements that cause damage to other materials. Polyethylene makes Pipe with the Stripe mechanically and chemically resistant to the devastating conditions that corrode metal pipes.

Durable

This results in an increased lifespan and greater efficiency. Your system will profit from lower maintenance costs, dependable hydraulic performance and superior lifecycle costing.

Easy to Handle

The flexibility of Pipe with the Stripe allows for bending during installation. Breaking due to expansion and contraction is virtually eliminated. Pipe with the Stripe can absorb shock water hammer or sudden impact without suffering damage- even in extremely cold conditions.

Smoother Flow

The smooth interior walls of Pipe with the Stripe provide a lifetime of operation with no loss of carrying capacity. And due to a high Hazen Williams flow coefficient of C=150, substantial savings can be enjoyed over the life of the system.

Ensures Water Quality

Our pipe's smooth interior eliminates encrustants such as calcium from adhering to its surface. This ensures the water distribution line stays cleaner longer- providing better water quality.

User Friendly

Pipe with the Stripe needs no sophisticated tools or special equipment for installation. In fact, a simple handsaw is all you need for cutting. And the decreasing sequential markings every two feet save you both time and pipe.

Weather Resistant

Pipe with the Stripe features a unique formulation that protects it against any harmful effects from excessive ultraviolet rays. No special covering or protection for above- ground installations are required.

Chemical Resistant

Antifreeze products such as methanol (isopropyl alcohol) and ethylene glycol may be used with our polyethylene pipe. For any compatibility concerns, contact your IPEX representative for a copy of the IPEX Chemical Resistance Guide.

Standards

CSA B137.1

Third-party tested.

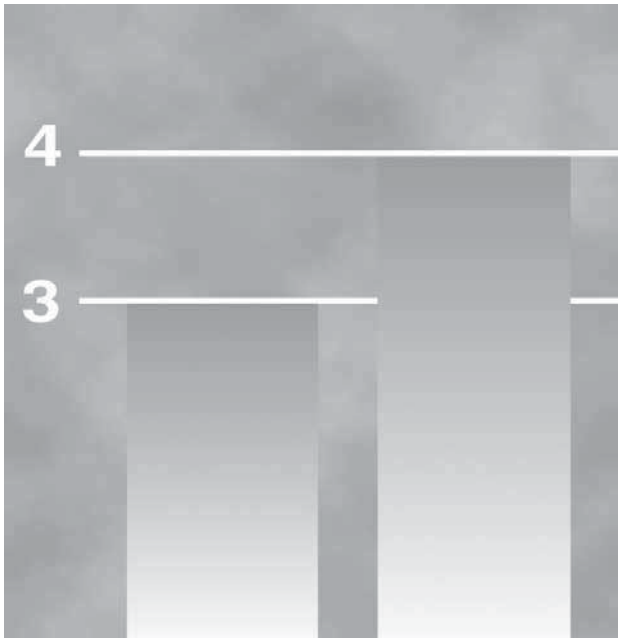
Quality Assurance

The following are some of the tests performed to ensure the highest quality of pipe for our customers.

Hydrostatic Pressure Test

To verify the pressure ratings of Pipe with the Stripe, the polyethylene pipe is subjected to a Quick Burst Test. These tests are conducted regularly for a duration of 60-70 seconds at designated pressure levels well above the pipe rating. Refer to the following table for safety factors.

Safety Factors



Kellan Stress-Cracking Test

This test measures the strength of polyethylene pipe against active chemical reagents while the pipe is under stress. Pipe subjected to this stress testing is coated with an active organic solvent, and twice the nominal pressure of the pipe is applied. After eight continuous hours, the pipe must show no signs of cracking to successfully pass the test.

Sizes & Dimensions

Standard Polyethylene Pipe
Available in Convenient Coils and Reels

White Stripe	Series 75	75 psi	517 kPa
Blue Stripe	Series 100	100 psi	689 kPa
Black Stripe, Poly Blue	Series 100	100 psi	689 kPa for submersible pumps
Black Stripe, Poly Blue	Series 150	160 psi	1103 kPa for submersible pumps
Irrigation 2000	Series 80	100 psi	689 kPa
Utility Pipe	Series 50	P max 50 psi	

CSA-Certified Polyethylene Pipe

CSA 50	Series 50	50 psi	345 kPa
Red Stripe	Series 75	75 psi	517 kPa
Green Stripe	Series 100	100 psi	689 kPa

Dimensions

Nominal Size (inches)	Avg. Inside Diameter	Nominal Size (mm)	Avg. Inside Diameter
1/2	0.62	12	15.80
3/4	0.82	20	20.90
1	1.05	25	26.60
1 1/4	1.38	32	34.95
1 1/2	1.61	40	40.80
2	2.06	50	52.35
3	3.06	75	77.60

NOTES

Thermal Expansion and Contraction

IPEX Pipe with the Stripe provides excellent thermal expansion and thermal contraction capabilities. The pliability of this pipe expressed by a modulus of elasticity is equal to 80,000 psi. This allows the pipe to fully resist tension and compressive forces without breaking.

The expansion coefficient of this pipe is 8×10^{-5} in./in.°F (1.44×10^{-4} mm/mm°C).

This value is the equivalent of 1" for every 10°F temperature change for every 100 ft. of pipe.

Hydraulics

Flow in the Pipe with the Stripe can be designed using the Hazen-Williams equation:

Q = flow rate (USGPM)

$$Q = 0.442\ Di_{2.63}\ C \left[\frac{P_1 - P_2}{L}\right]^{.54}$$

or

$$Q = 0.006756\ C\ Di^{2.63}\ H^{.54}$$

Di = pipe internal diameter

C = flow coefficient (C=150)

$P_1\ P_2$ = gauge pressure (psi)

L = pipe length (ft)

H = head loss (ft. H_20/1,000 ft.)

Note: Calculations in this section are related to water transmission.

Friction Loss in Feet of Head per 100 feet of Pipe

GPM	USGPH	1/2" ID 0.622"	3/4" ID 0.824"	1" ID 1.049"	1 1/4" ID 1.380"	1 1/2" ID 1.610"	2" ID 2.067"	3" ID 3.062"
2	120	4.1						
3	180	8.7	2.2					
4	240	14.8	3.7					
5	300	22.2	5.7	1.8				
6	360	31.2	8.0	2.5				
7	420	41.5	10.6	3.3				
8	480	53.0	13.5	4.2				
9	540	66.0	16.8	5.2				
10	600	80.5	20.4	6.3	1.7			
12	720		28.6	8.9	2.3	1.1		
14	840		38.0	11.8	3.1	1.4		
16	960		48.6	15.1	4.0	1.9		
20	1200		60.5	22.8	6.0	2.8		
25	1500			38.7	9.1	4.3	1.3	
30	1800				12.7	6.0	1.8	
35	2100				16.9	8.0	2.4	
40	2400				21.6	10.2	3.0	
45	2700				28.0	12.5	3.8	
50	3000					15.4	4.6	
60	3600					21.6	6.4	
70	4200					28.7	8.5	1.2
80	4800					36.8	10.9	1.4
90	5400					45.7	13.6	1.8
100	6000					56.6	16.5	2.2
120	7200						23.1	3.0
140	8400						30.6	4.0
160	9600						39.3	5.0
200	12000							7.6
260	15600							12.2
300	18000							15.8

Temperature Effects

The pressure rating of Pipe with the Stripe is determined at 23°C (73.4°F). If this pipe is used at different temperatures, the nominal pressure rating of Pipe with the Stripe should be decreased or increased accordingly.

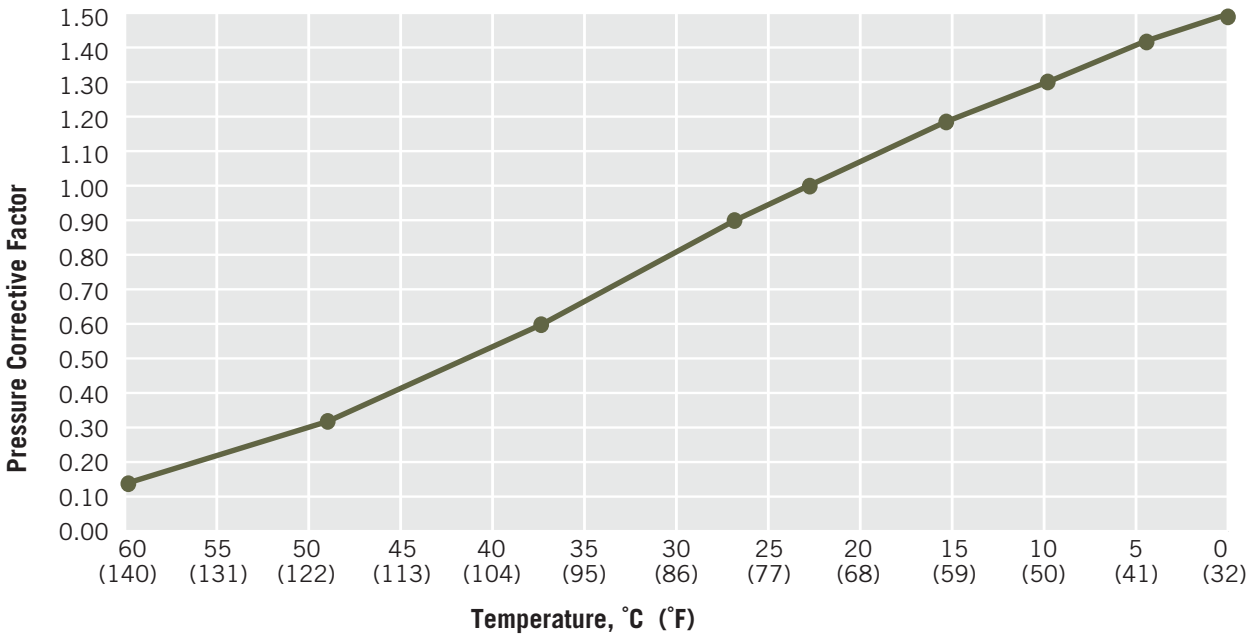
Table of Head Loss for Fittings

Fittings cause some flow restrictions and produce some pressure loss. The following table shows pressure loss based on the equivalent value of the pipe length for the specified fittings.

Type of Fitting	Material	Nominal Size of Fitting and Pipe					
		1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
		Equivalent Length of Pipe (in feet)					
Insert Coupling	Plastic	3	3	3	3	3	3
Threaded Adapter (Plastic to Thread)	Plastic	3	3	3	3	3	3
90° Standard Elbow	Steel	2	3	3	4	4	5
	Plastic	4	5	6	7	8	9
Standard Tee (Flow Through Run)	Steel	1	2	2	3	3	4
	Plastic	4	4	4	5	6	7
Standard Tee (Flow Through Side)	Steel	4	5	6	6	9	11
	Plastic	7	8	9	9	13	17
Gate Valve*	Steel	2	3	4	5	6	7
Swing Check Valve*	Steel	4	5	7	9	11	13

Notes: Based on Schedule 40 and plastic fittings. Figures given are friction losses in terms of EQUIVALENT LENGTHS (in feet) of straight pipe.

*Friction loss figures are for screwed valves and are based on equivalent lengths of pipe.



Installation

Assembly and Joining

Installing Pipe with the Stripe is simple. Prepare pipe ends for insert fittings or compression fittings by cutting the pipe square. This is easily done with a hacksaw, or a carpenter's saw with fine-tooth blades. All burrs and cuttings must be removed to ensure a good reliable joint. Barbed insert fittings and compression fittings are commonly used to join polyethylene pipe, and are available in many styles.

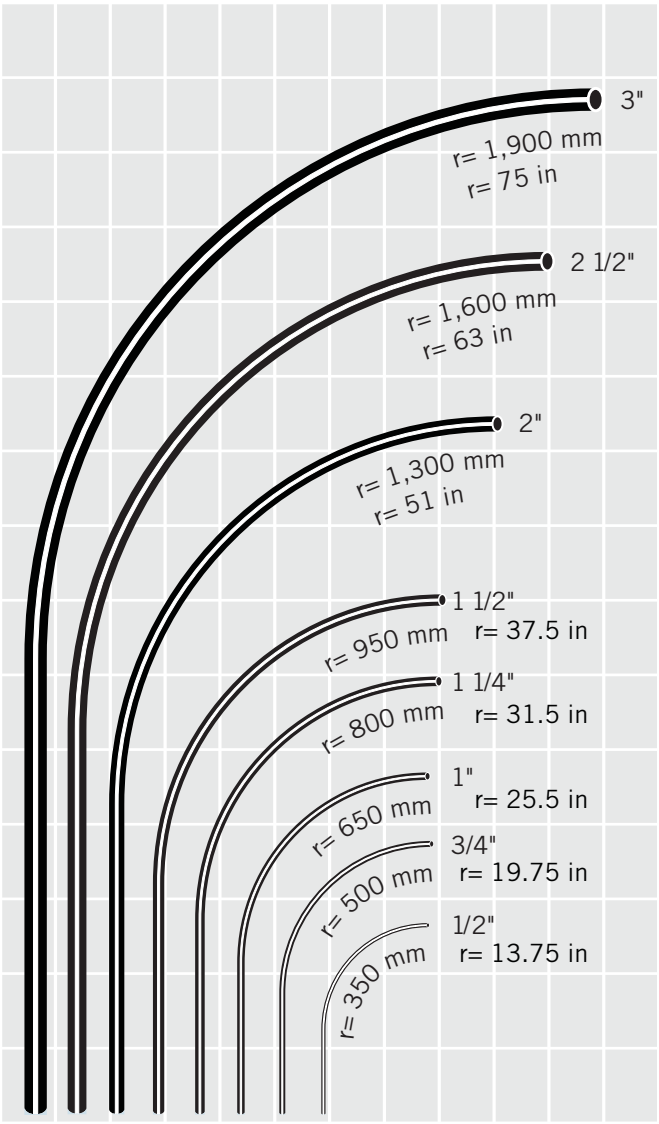
For insert fittings, force the pipe end over the barbs of the fitting until it makes contact with the shoulder. If necessary, the pipe may be softened by immersing the end into hot water. Two stainless steel clamps are used to secure the fitting to the pipe. Tighten clamps to provide a leaktight connection. Note that the clamp screw positions should be offset by 180 degrees.

A polyethylene pipe may be bent to avoid obstacles or to save on the use of fittings. Follow the recommendations below.

Underground Installation

If installed pipe is expected to contract, it should be snaked in the trench. However, if expansion is anticipated, it should be installed straight and brought up to service temperature. The trench is then backfilled in the normal manner.

The bottom of the trench and the backfill material must be free of stones, rocks, or debris that may damage the pipe.



Choosing the Correct Pipe for the Job

Always choose a polyethylene pipe with a pressure rating at least as high as the maximum pressure rating on the system. To do this, we must calculate the correct pipe working pressure that our system will require.

1. This is best illustrated through an example. To begin, the well driller must provide us with the well output. In our example, the well will deliver 10 USGPM. We must then calculate the draw down level. This is the sum of the static water level (level of water table) + draw down (drop in water level caused by pump) from the ground level. The draw down level is the level at which the water stands when the pump is operating. The highest pressure in the water system is encountered at the draw down level. At this point the pipe will be under pressure from the pump as well as the weight of the water in the pipe.

   100 ft. + 3 ft. = 103 ft. head

2. Calculate the friction loss in the well line. Using Table A to calculate friction losses, the length, size and type of all piping, fittings and valves must be known. We have chosen 1¼" pipe because it can handle a flow rate of 10 USGPM

   $$110 \text{ ft.} \times \frac{1.7 \text{ ft. of head}}{100 \text{ ft.}} = 1.87 \text{ ft. head}$$

3. Determine if there is any elevation in the pressure tank from the top of the well. This elevation is measured in ft. of head.

   Elevation of pressure tank = 10 ft. head

4. Determine the maximum pressure switch setting on the pressure tank. This setting usually ranges from 30 to 50 psi. We will assume the end user wants a pressure on his distribution system of 50 psi. This psi setting must be converted to ft. or head.

   1 psi = 2.31 ft. of head

   therefore, 50 psi = 115.5 ft. of head

5. Calculate the friction loss in the supply line to the pressure tank.

   $$30 \text{ ft.} \times \frac{1.7 \text{ ft. of head}}{100 \text{ ft.}} = .51 \text{ ft. head}$$

6. Calculate the friction loss in ft. or head for all fittings in the supply line. From Table B: To do this, we must first convert to an equivalent feet of pipe

1- 90° bend	= 1 x 7 ft.	=	7 ft. of pipe
1- T flow through side	= 1 x 12 ft.	=	12 ft. of pipe
Total		=	19 ft. of pipe

   We must convert feet of pipe to feet of head

   $$19 \text{ ft. of pipe} \times \frac{1.7 \text{ ft. of head}}{100 \text{ ft.}} = .32 \text{ ft. head}$$

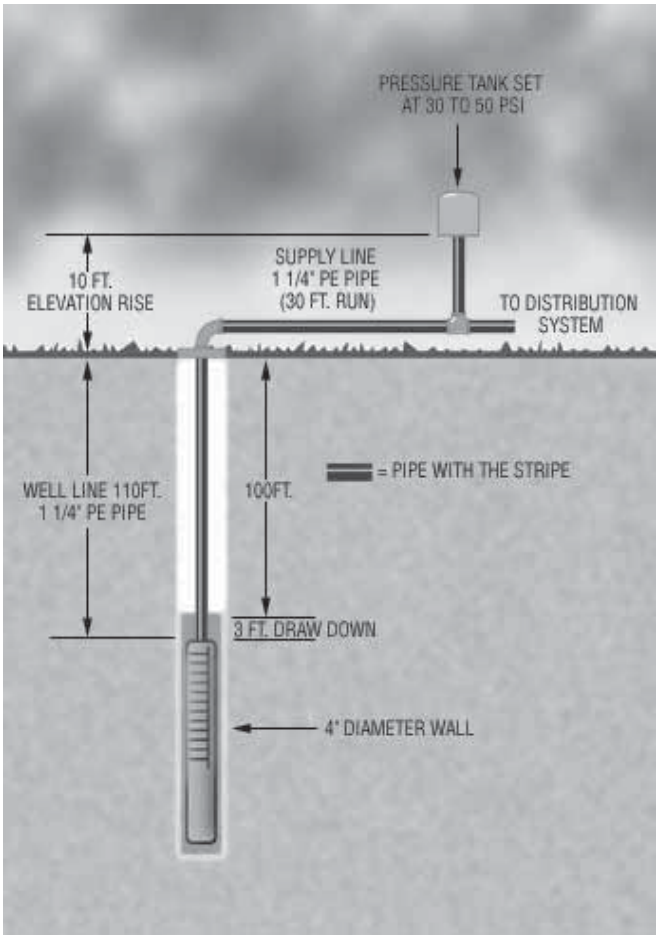
   The total pumping head is the sum of steps 1 through 6

   Total Pump Head =
   103 + 1.87 + 10 + 115.5 + .51 + .32

   = 231.2 ft. head

   $$\text{Converting this to psi} = \frac{231.2 \text{ ft. head}}{2.31 \text{ ft. head/psi}} = 100 \text{ psi}$$

7. Therefore: we would recommend using a Series 100 polyethylene pipe for this application.



Appendix A: Reference Tables and Conversion Charts

Table A-1 Weights of Water

Units of Volume	Weight	
	pounds	kilograms
1 US Gallon	8.350	3.791
1 Imperial Gallon	10.020	4.549
1 litre	2.210	1.003
1 cubic yard	1,685.610	765.267
1 cubic foot	62.430	28.343
1 cubic inch	0.036	0.016
1 cubic cm	0.002	0.001
1 cubic metre	2,210.000	1,000.000

Table A-2 Volume Conversion

Units of Volume	in^3	ft^3	yd^3	cm^3	m^3	liter	U.S. gal.	Imp. gal.
cubic inch	1	0.00058	-	16.387	-	0.0164	0.0043	0.0036
cubic foot	1728	1	0.0370	28,317.8	0.0283	28.32	7.481	6.229
cubic yard	46,656	27	1	-	0.7646	764.55	201.97	168.8
cubic centimeter	0.0610	-	-	1	-	0.001	0.0003	0.0002
cubic meter	61,023.7	35.31	1.308	-	1	1000	264.17	220.0
liter	61.02	0.0353	0.0013	1000	0.001	1	0.2642	0.22
U.S. gallon	231	0.1337	0.0050	3785.4	0.0038	3.785	1	0.8327
Imp. gallon	277.42	0.1605	0.0059	4546.1	0.0045	4.546	1.201	1

Table A-3 Temperature Conversion

Degrees Celsius	$°C = \frac{5}{9}(°F - 32)$	Degrees Fahrenheit	$°F = \frac{9}{5}°C + 32$
Degrees Kelvin	$°T = °C + 273.2$	Degrees Rankine	$°R = °F + 459.7$

Table A-4 Length Conversion

Units of Length	in.	ft.	yd.	mile	mm	cm	m	km
inch	1	0.0833	0.0278	-	25.4	2.54	0.0254	-
foot	12	1	0.3333	-	304.8	30.48	0.3048	-
yard	36	3	1	-	914.4	91.44	0.9144	-
mile	-	5280	1760	1	-	-	1609.3	1.609
millimeter	0.0394	0.0033	-	-	1	0.100	0.001	-
centimeter	0.3937	0.0328	0.0109	-	10	1	0.01	-
meter	39.37	3.281	1.094	-	1000	100	1	0.001
kilometer	-	3281	1094	0.6214	-	-	1000	1

(1 micron = 0.001 millimeter)

Appendix B: Abbreviations

AGA	- American Gas Association
ANSI	- American National Standards Institute
API	- American Petroleum Institute
ASME	- American Society of Mechanical Engineers
ASTM	- American Society for Testing and Materials
AWWA	- American Water Works Association
BNQ	- Bureau de Normalization du Quebec
BOCA	- Building Officials and Code Administrators
BS	- British Standards Institution
CPVC	- Chlorinated poly (vinyl chloride) plastic or resin
CS	- Commercial Standard, see Product Standard
CSA	- Canadian Standards Association
DR	- Dimension Ratio
DIN	- German Industrial Norms
FHA	- Federal Housing Administration or Farmers Home Administration
HDB	- Hydrostatic design basis
HDS	- Hydrostatic design stress
IAPD	- International Association of Plastics Distributors
IAPMO	- International Association of Plumbing and Mechanical Officials
IPC	- International Plumbing Code
ISO	- International Standards Organization
JIS	- Japanese Industrial Standards
NSF	- National Sanitation Foundation International
PPI	- Plastics Pipe Institute
PS	- Product Standard when in reference to a specification for plastic pipe and fittings. These specifications are promulgated by the U.S. Department of Commerce and were formerly known as Commercial Standards.
PSI	- Pounds per square inch
PSIG	- Gage pressure in pounds per square inch
PVC	- Poly (vinyl chloride) plastic or resin
RVCM	- Residual Vinyl Chloride Monomer
SCS	- Soil Conservation Service
SDR	- Standard Dimension Ratio
SI	- International System of Units
SPI	- Society of the Plastics Industry, Inc.
UPC	- Uniform Plumbing Code
USASI	- United States of America Standards Institute (formerly American Standards Association)
WOG	- Water, Oil, Gas

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About the IPEX Group of Companies

As leading suppliers of thermoplastic piping systems, the IPEX Group of Companies provides our customers with some of the largest and most comprehensive product lines. All IPEX products are backed by more than 50 years of experience. With state-of-the-art manufacturing facilities and distribution centres across North America, we have earned our reputation for product innovation, quality, end-user focus and performance.

Markets served by the IPEX Group of Companies include:

- Electrical systems
- Telecommunications and utility piping systems
- Industrial process piping systems
- Municipal pressure and gravity piping systems
- Plumbing and mechanical piping systems
- Electrofusion systems for gas and water
- Industrial, plumbing and electrical cements
- Irrigation systems
- PVC, CPVC, PP, PVDF, PE, ABS, and PEX pipe and fittings

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