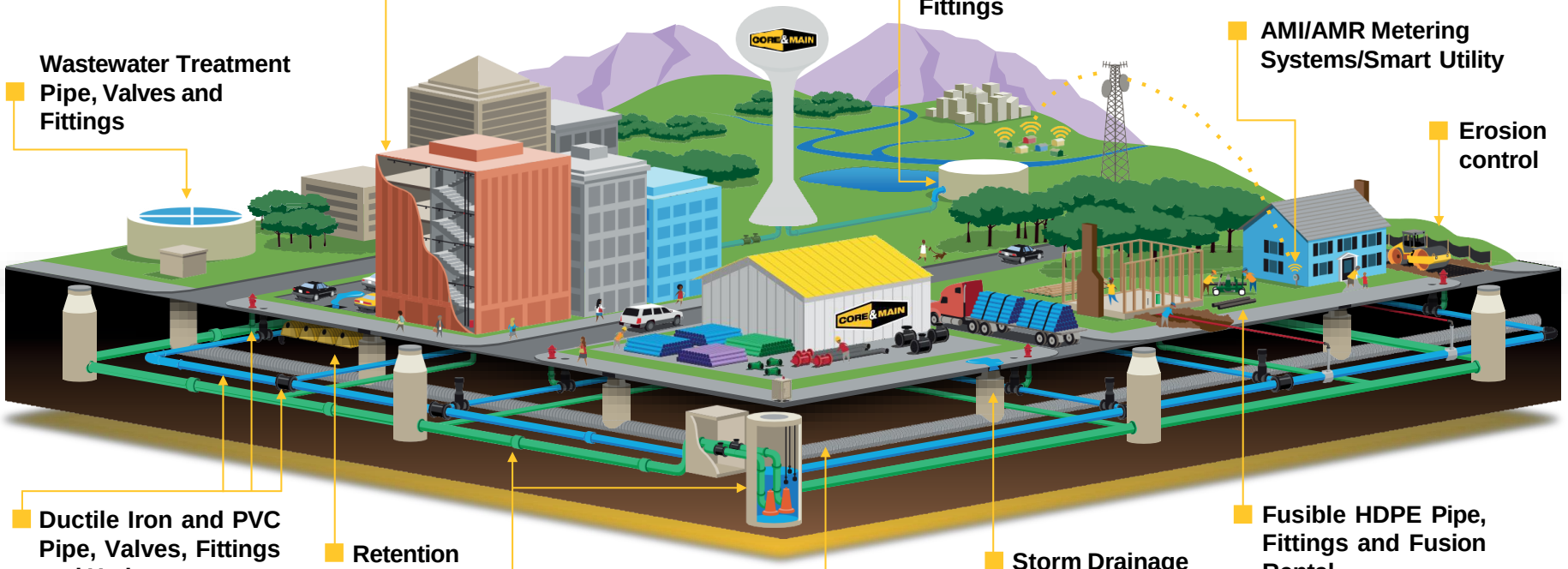
HDPE Pipe for Trenchless Rehabilitation of Water & Wastewater Systems

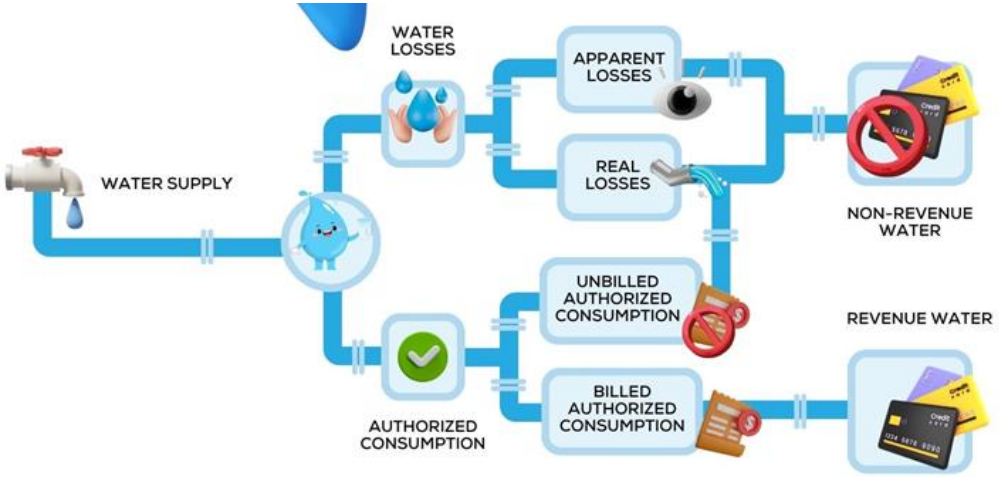
Illinois Rural Water - 2026

PRODUCTS AND SERVICES



Risks with Aging Infrastructure

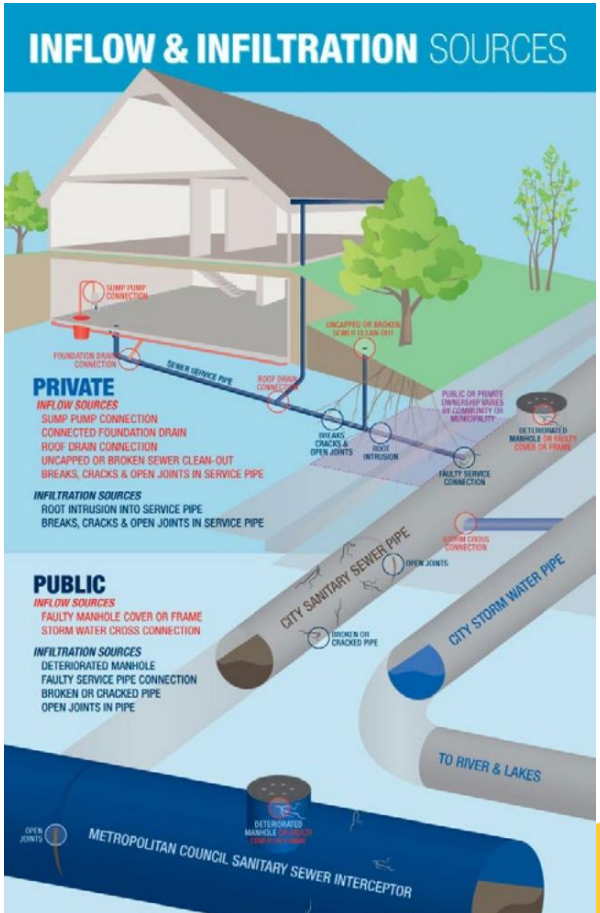
- Water Loss
- Infiltration/Inflow
- Disinfectant Use
- Constant Crisis Mode
- Budget Uncertaintity



I & I, What? Where? How?

- Leaking pipes
- Manholes
- Low Manholes
- Sump Pumps, Foundation Drains, Roof Drains

- I/I accounts for up to 45% of the annual flow to the treatment plant
- On average, 81% of WWTPs are operating at over 75% of their design capacity
- An estimated 15% of WWTPs have reached or exceeded their design capacity
- The National Pollutant Discharge Elimination System (NPDES) regulates point-source discharges and may demand increased storage capacity



How Long does Pipe Last?

- Cast Iron – Depends on when installed
- Ductile Iron – 50-75 years
- PVC - 75-100 years
- Copper
- Asbestos Cement – 50 -75 years
- HDPE – 100 years

AWWA C906-15

- **HDPE pipe made from PE 4710 Resin**
  - **Plastic Pipe Institute Allowable Leak Calculator**

Plug in your city's population here, then hit Enter key:

7500

PE Pipe	PVC Pipe	Ductile Iron Pipe
0	906,359	1,002,609

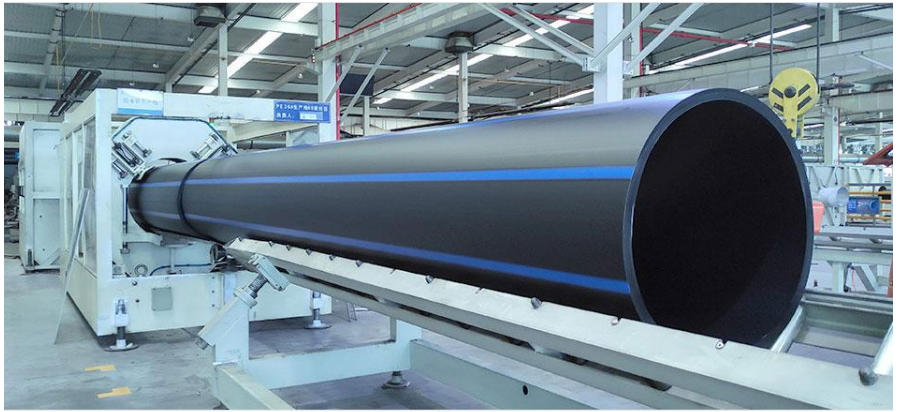
Gallons of water allowed to leak per year

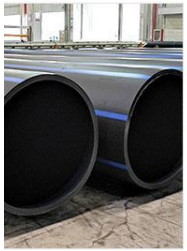
0	45,317,944	50,130,469

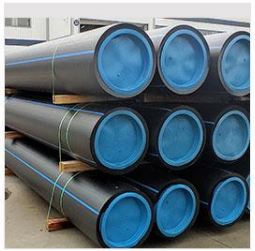
Gallons of water allowed to leak over the next 50 years

- Based on 12-inch AWWA C906(for PE), C900 (for PVC), and C110 (for DI) pipe at 100 psi
- Assumes approximately 100,000 people per 292 miles of pipe
- AWWA Manual M23: PVC Pipe Design and Installation
- AWWA Manual M41: Ductile-Iron Pipe and Fittings

How is it Made?







- Extruded in Continuous Stream

- PE4710 Resin
- IPS, DIPS, multiple DRs
- Can be Coiled to 6”
- Typically 40’ & 50’ lengths

See it made!

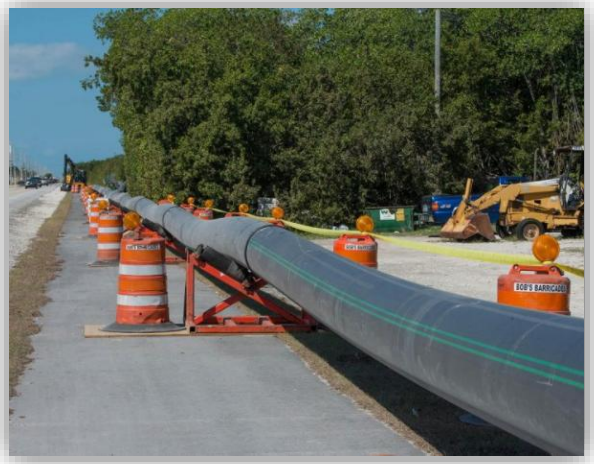
HDPE Advantages

- Fused Joints
- Flexibility
- Ductility/Toughness
- Cold Weather Performance
- High Impact Strength
- Chemical Resistance
    - UV Resistance
    - Hydraulic Efficiency
    - Handles Surges Above Pressure Rating

HDPE *Butt Fused* Joint

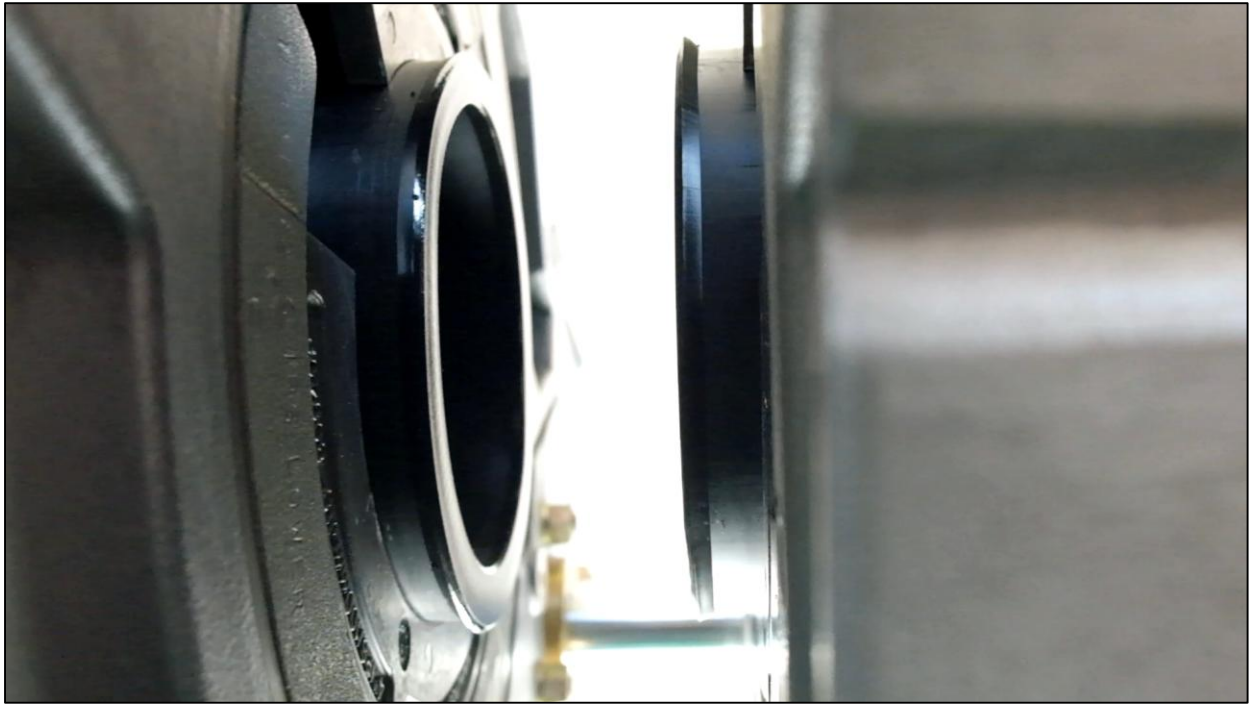
Homogeneous, monolithic fusion joint

- Zero Leak Joint – No allowable leakage
- Fully Restrained – Joint as strong as pipe
- Allows Installation Under Tension – Pull-In/Through
- Eliminates Restraints, Bolts, Gaskets & Thrust Blocks
- Field Fusions recognized in AWWA – The only one!



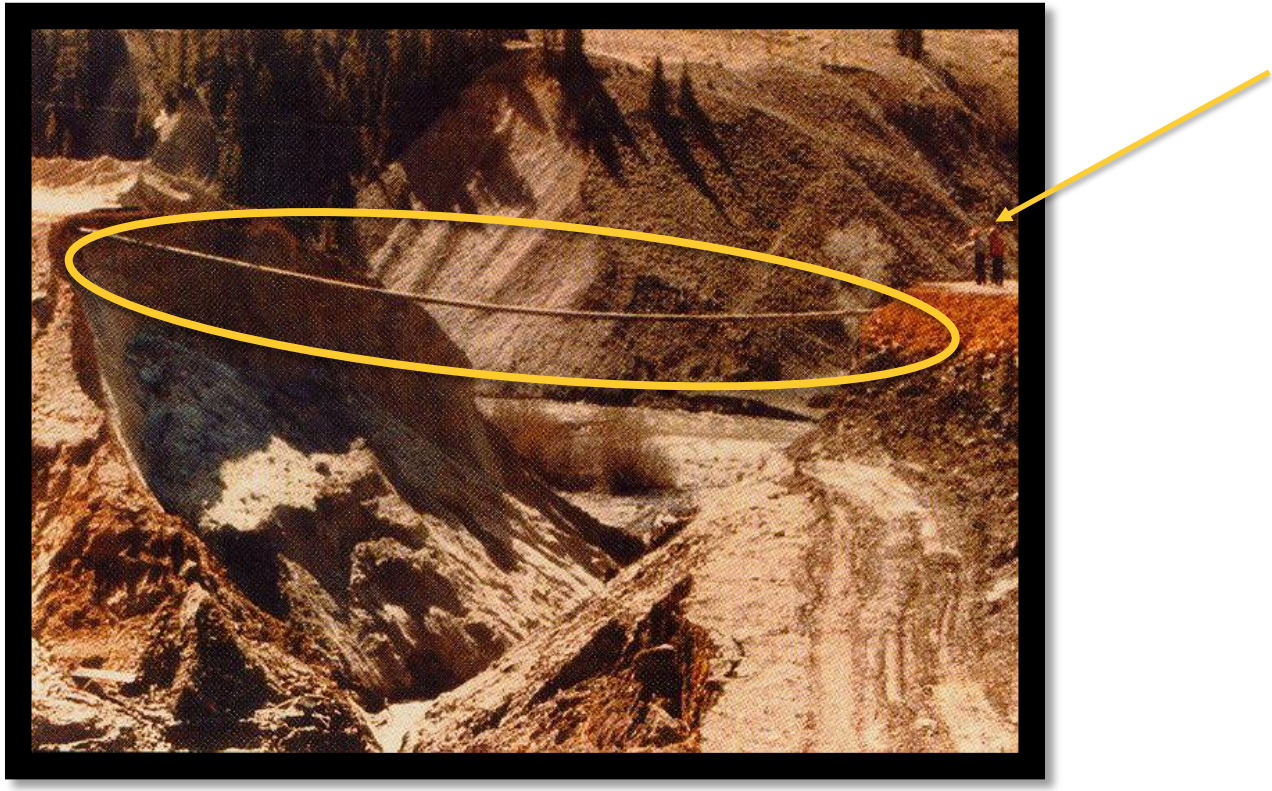
Burst Pressure DR11 PC 200
3.2 x 200psi = 640psi

Butt Fused Joint



Superior Leak Free Resistance

Fully Restrained Fusion Joints



HDPE Tensile Strength

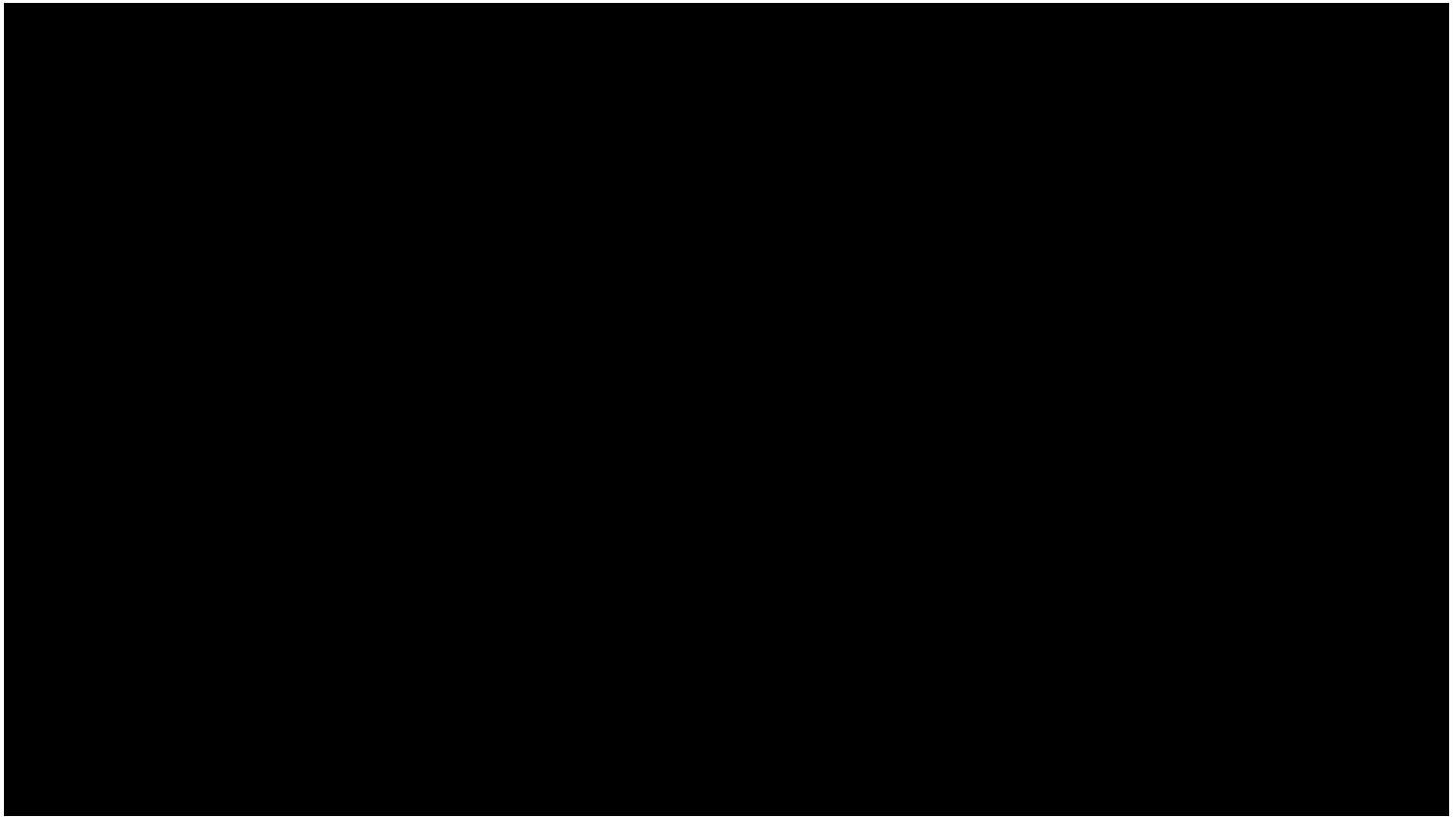
- 3200 psi Tensile Yield Strength
- Safe Pull based on safety factor of 2.5

Example: 12” DIPS DR11

Safe Pull = 57,922 lbs

CRJ200 Weighs 52,000 lbs

HDPE Impact Resistance

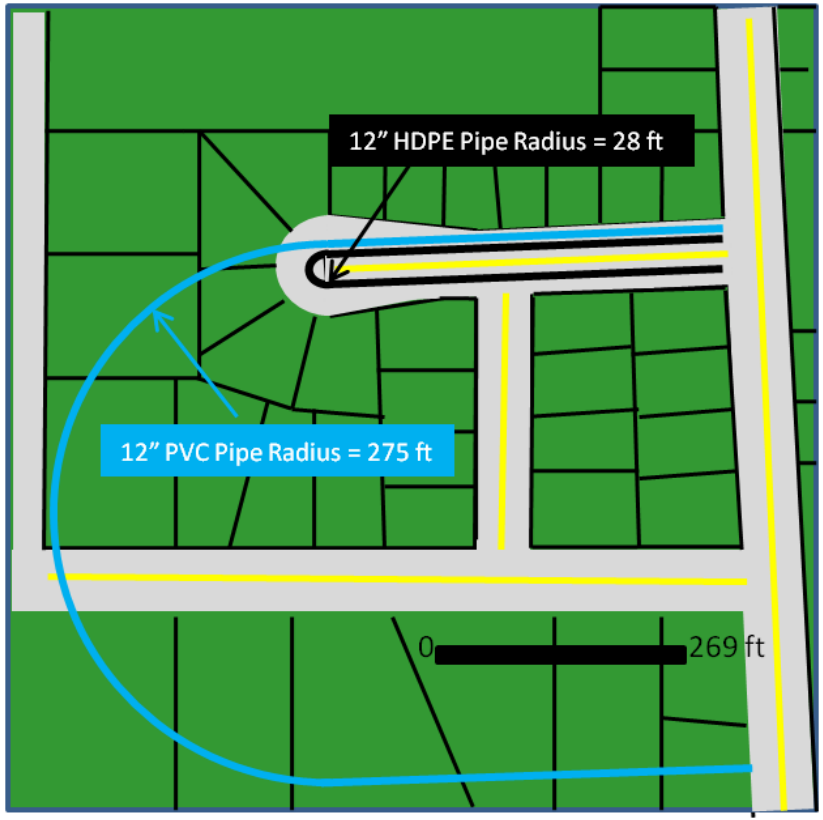


HDPE Flexibility

- Allowable Bend Radius
  DR11 = 25 X OD
- Eliminates fittings
- Allows for trenchless installations

HDPE Bend Radius

- HDPE can be bent 10 times tighter than trenchless PVC pipe
- 12 DIPS DR 11 HDPE
  (25 x OD) = 28’
- 12” DIPS DR 18 PVC
  (250 x OD) = 275’ (10x)



HDPE Design

- Handbook of PE Pipe - PPI

HDPE Design

- Understand how HDPE pipe reacts to thermal and pressure changes.
- Thermal Expansion/Contraction is easily restrained
- On HDPE pipe using bends, backfill, or thrust blocks
- On legacy pipe using external joint restraints or thrust blocks
- “Snaking” pipe in trench or on ground

Thermal Delta
1” per 100’ per 10°F

Electrofusion Flex Restraint - (Standard Dimension Ratio) 125 PSI (Working Pressure at 73.4° F)

Nominal Size	Axial Resistance	L1	L2	L3	Unit Weight	Item Code
6" - 63" IPS / DIPS	9,500 lbs.	7.50"	2.45"	1.56"	0.42 lbs.	200400

6" IPS/DIPS - 10" IPS/DIPS fusible to SDR 9 to SDR 17
12" IPS/DIPS - 63" IPS fusible to SDR 9 to SDR 26

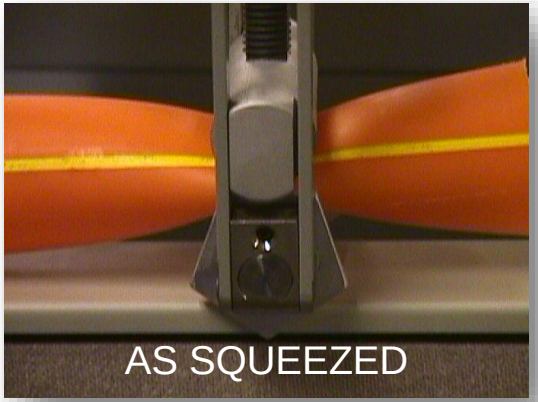
Number of Restraints Needed for SDR **	6"	8"	10"	12"	14"	16"	18"	20"	24"	28"	30"	32"	36"	42"	48"
SDR 9	2	2	3	4	4	5	7	8	11	15	18	20	25	34	44
SDR 11	2	2	2	3	4	5	6	7	10	13	15	17	21	29	37
SDR 17	2	2	2	2	3	3	4	5	7	9	10	11	14	19	25
Max # of Restraints in Perimeter	3	4	5	6	7	8	9	10	12	14	15	16	18	21	25

Poisson Effect

TABLE A2
Approximate Poisson Effect Pullout Force

DIPS Pipe Size (DR 11)	Approximate Pullout Force, lbs (a)		
	Operating at Full Rated Pressure (b)	During Pressure Tests at 150% of Rated Pressure (c)	Operating at Full Rated Pressure Plus Maximum Allowable Occasional Surge Pressure (d)
4”	1,892	2,208	3,364
6”	4,102	4,786	7,293
8”	6,953	8,112	12,361
10”	10,801	12,602	19,202
12”	15,195	17,727	27,013
16”	23,928	27,916	42,539

Ductility/Toughness Squeeze off



Low Temperature Performance

- Water can freeze in HDPE pipe without damage.
- Service temperatures as low as -50^{o}F.
- Very high impact strength

HDPE Chemical Resistance

- Does not interact with most materials
  - Material of choice in the packaging industry

Steel & DIP Corrosion

- Steel & DIP with Age
- Corrosion and tuberculation
- Flow restriction + velocity increase

Steel pipe – 9 years

Steel pipe – 6 months

HDPE Corrosion Resistance

HDPE Water Pipe

HDPE pipe – 4 years

Courtesy Duke Energy Corp.

HDPE pipe – 41 years

Courtesy Lyondell Basell

HDPE Surge Resistance

HDPE Water Pipe

*The following table gives the Pressure Class per AWWA C901-08, the Pressure Rating and Allowable Total Pressure During Surge for **PE4710** pipe at 80o F.*

Sample Pipe Dimension Ratio (DR)	*Pressure Class*	*Pressure Rating*	*Allowable Total Pressure During Recurring Surge*	*Allowable Total Pressure During Occasional Surge*
DR 9	*250 psi*	*250 psi*	*375 psi*	*500 psi*
DR 11	*200 psi*	*200 psi*	*300 psi*	*400 psi*
DR 17	*125 psi*	*125 psi*	*185 psi*	*250 psi*

Let’s Talk Pipe

Pipe Standards
PE4710 – HDPE Water
ASTM F714, D3035
AWWA C901 & C906

Pipe Sizes
IPS = Iron Pipe Size
DIPS = Ductile Iron Pipe Size
CTS = Copper Tube Size

Learning from the Print Line

Manufacturer's Name or Trademark	Pipe Diameter, Diameter Basis, and DR/SDR	PE Material Type; indicated by Material Designation or cell classification	Product Standard(s), may include Pressure Rating or Pressure Class	Production Date may also include lot number, footage, and/or Package number	Other Markings can include Resin Codes, 3rd Party Certification codes,

HDPE Fittings

MJ Connection

Injection Molded

There are a wide variety of fittings that can be fused directly to HDPE pipe

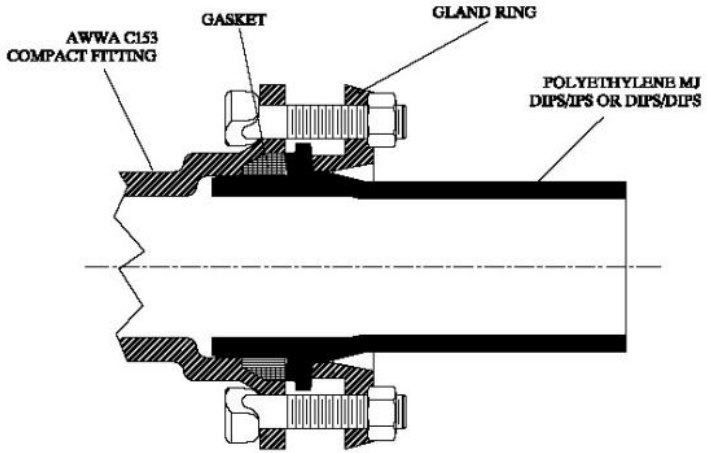
Fabricated

Electrofusion

HDPE Fittings

An HDPE MJ Adapter is a type of fitting specifically designed to connect High-Density Polyethylene (HDPE) pipes to systems or components made from different materials, such as PVC or ductile iron.

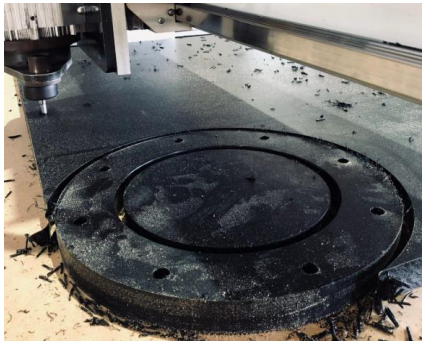
"MJ" stands for Mechanical Joint, a connection method that uses a gasket and



HDPE Fittings

HDPE Fabricated Fittings are components made from HDPE pipe and sheet stock.

Unlike injection-molded fittings, which are produced through injection molding, fabricated fittings are created by joining pieces of HDPE pipe or flat stock through processes like fusion or CNC machining.



HDPE Fabricated Fittings

Because of forces due to velocity and change of direction, fabricated fittings are often de-rated and are thus made from a thicker DR pipe

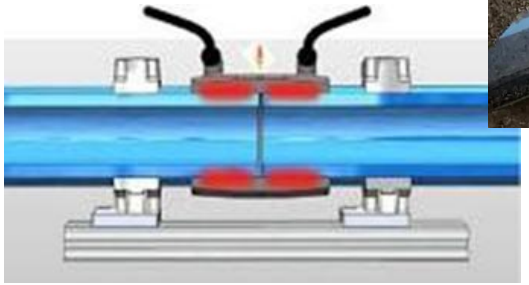
Derating Factors For HDPE P4710 Fittings @73.4° F								
NOTE: These pressures apply only when used in unison with PE4710 Pipe								
Description	Industry Standard Derating	FITTINGS MANUFACTURED WITH THIS SDR HAVE THE WPR LISTED *WPR						
		7	9	11	17	21	26	32.5
Fabricated 90 degree Ell - Five Segment *A	ONE (1) SDR	252	200	160	100	80	65	50
Fabricated 90 degree Ell - Three Segment *B	ONE (1) SDR	252	200	160	100	80	65	50
Fabricated 45 degree Ell - Three Segment *A	ONE (1) SDR	252	200	160	100	80	65	50
Fabricated 45 degree Ell - Two Segment *B	ONE (1) SDR	252	200	160	100	80	65	50
Fabricated 22.5 degree Ell - Two Segment *A	ONE (1) SDR	252	200	160	100	80	65	50
Fabricated Wye, Three piece *B	ONE (1) SDR	252	200	160	100	80	NA	NA
Fabricated Cross *B	TWO (2) SDRS	200	160	100	80	65	NA	NA
Reducing Tee - Branch Saddle *C	NONE *C	336	252	200	126	100	80	64
Eccentric Reducers	CUSTOM MANUFACTERED TO REQUIRED WPR							
HDPE Blind Flanges	HDPE BLIND FLANGES ARE NOT RATED FOR INTERNAL PRESSURE. FOR INTERNAL PRESSURE THEY MUST BE USED IN COMBINATION WITH STEEL BLIND FLANGES. THEY MAY BE USED IN CERTAIN VACUMM APPLICATIONS.							

Ends can be machined to match the thickness of the mainline pipe

Electrofusion Fittings

Electrofusion (EF) is a process where specialized electrofusion fittings are used to join two sections of HDPE pipe or a fitting to the side of an HDPE Mainline.

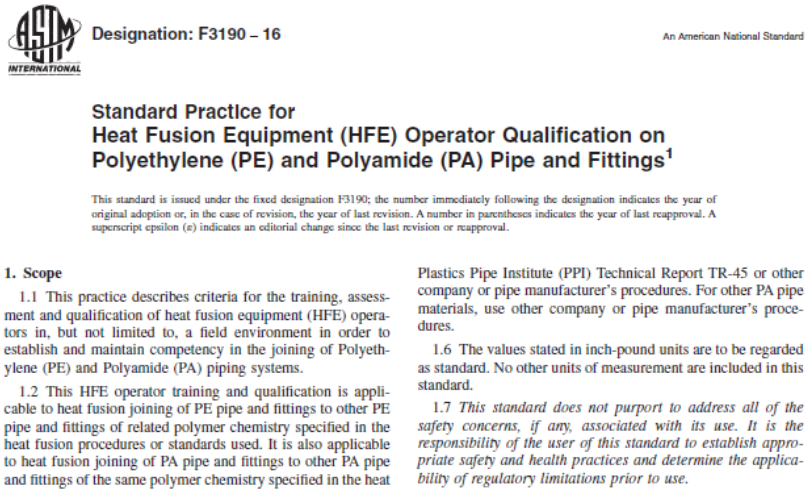
Electrofusion fittings are manufactured with a precision designed resistance wire heating coil mechanism built-in.



Butt Fusion

Butt fusion is the most common method of joining PE pipe. The process creates a distinctive double roll back bead.

Butt Fusion Operator Qualification



Designation: F3190 – 16

An American National Standard

Standard Practice for
Heat Fusion Equipment (HFE) Operator Qualification on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings[1]

This standard is issued under the fixed designation F3190; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes criteria for the training, assessment and qualification of heat fusion equipment (HFE) operators in, but not limited to, a field environment in order to establish and maintain competency in the joining of Polyethylene (PE) and Polyamide (PA) piping systems.

1.2 This HFE operator training and qualification is applicable to heat fusion joining of PE pipe and fittings to other PE pipe and fittings of related polymer chemistry specified in the heat fusion procedures or standards used. It is also applicable to heat fusion joining of PA pipe and fittings to other PA pipe and fittings of the same polymer chemistry specified in the heat Plastics Pipe Institute (PPI) Technical Report TR-45 or other company or pipe manufacturer's procedures. For other PA pipe materials, use other company or pipe manufacturer's procedures.

1.6 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

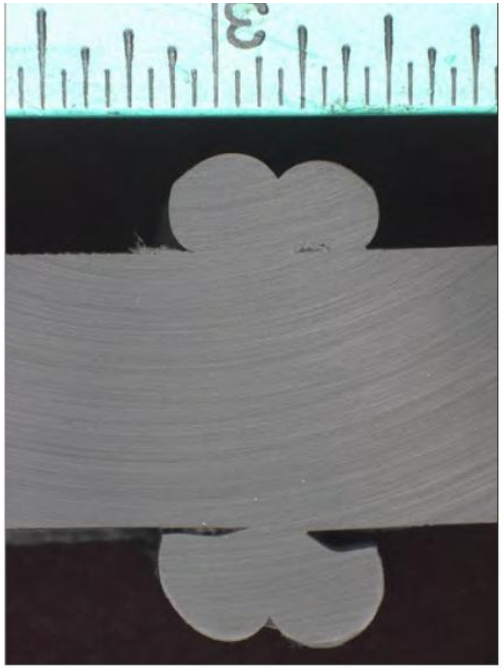
A properly trained fusion technician is the best assurance of a quality fusion joint.

ASTM F3190 outlines the required training.

Qualifications are renewed every two years.

Butt Fusion Principles

Butt fusion involves heating two pipe surfaces to create molten zones, and then bringing those molten zones together under pressure, allowing the materials to mix and cool, creating a monolithic system.



12-inch IPS Pipe, DR 11, Fusion Joint Cross-section

HDPE Butt Fusion

CLEAN

LOAD

FACE

HEAT

FUSE

INSPECT

ASTM F2620

Designation: F2620 – 19

An American National Standard

Standard Practice for
Heat Fusion Joining of Polyethylene Pipe and Fittings[1]

This standard is issued under the fixed designation F2620; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (′) indicates an editorial change since the last revision or reapproval.

Other Types of HDPE Fusion - Socket

Socket fusion is a joining technique for pipes and fittings made from thermoplastic materials like High-Density Polyethylene (HDPE). It's particularly well-suited for smaller diameter pipes and fittings.

Socket fusion involves simultaneously heating the outer surface of the pipe end and the inner surface of the socket fitting until the material reaches the recommended fusion temperature. Once the surfaces are melted, the pipe and fitting are pressed together to form a strong and durable connection as they cool.

Other Types of HDPE Fusion - Sidewall

HDPE pipe sidewall fusion, also known as saddle fusion, is a method used to join a branch pipe (a smaller pipe) to the side of a main pipe (a larger pipe). This creates a connection like a reducing tee or a saddle fitting.

Datalogger

Tablet-based, real time data logging device

Offers guided workflow during the fusion process

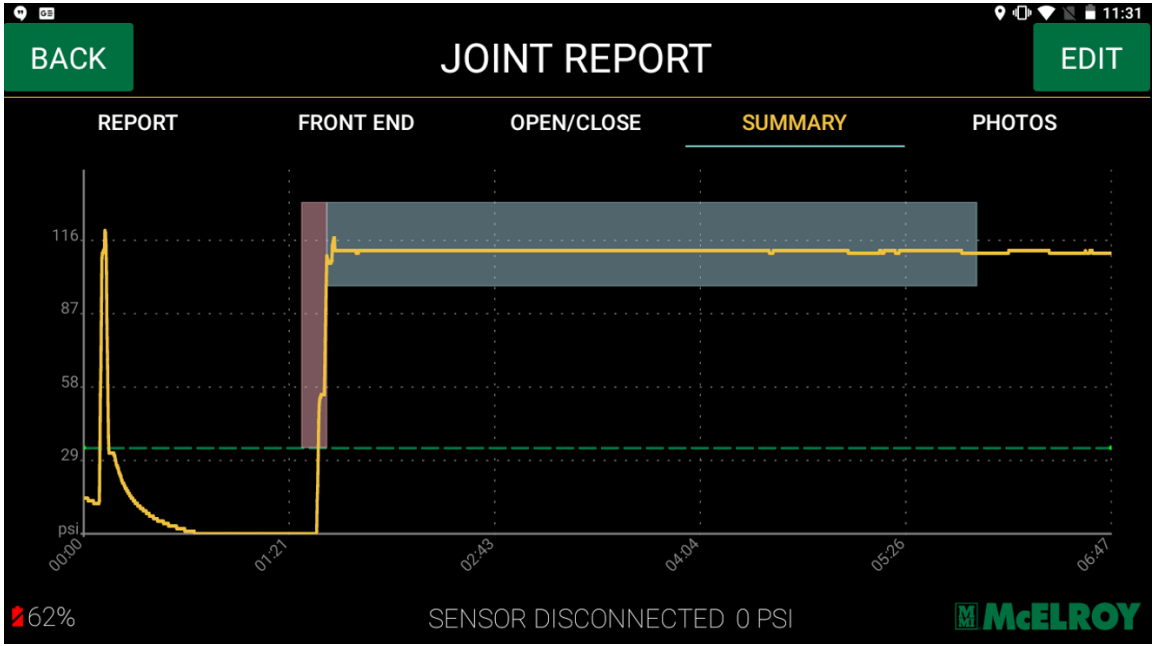
Securely stores joint reports in the cloud-based Vault

Datalogger

Connects to hydraulic fusion machines via digital pressure sender

Offers guided workflow during the fusion process
Securely stores joint reports in the cloud-based Vault

Datalogger



Real-time graphic of fusion process

Interfacial Pressure:
Theoretical pressure range required to fuse one square inch of pipe.
Range allowed is 60-90 psi, typically use 75psi

This is not a machine pressure!
Used to calculate machine pressures.

McElroy Vault

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IN **ONE LOCATION**

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CORE & MAIN

McElroy Joint Report

Reference Number 3519576

Job Details

Joint Number	6
Joint Time	2022-10-11 11:42:09 GMT
Job	Offut AFB
Operator	Training

Fusion Machine

Machine Name	C53664
Machine Model	PB20 HF
Piston Area	4.71 in²

Pipe Specifications

Pipe Material	PE 4710
Pipe Size	4 " IPS
Wall Thickness	DR 17

Pressures

Drag Pressure	20 psi		
		Interfacial	Gauge
Bead Up		75 psi	84 psi
Heat Soak		0 psi	20 psi
Fuse		75 psi	84 psi
Cool		0 psi	0 psi

Fusion Specification

Fusion Type	Butt Fusion
Fusion Specification	ASTM D2620
Bead Time	0 seconds
Bead Size	3/16"
Heat/Soak Time	71 seconds
Fuse Time	174 seconds
Open/Close Time	8 seconds
Cool Time	0 seconds

	Minimum	Maximum
Bead Up	72 psi	95 psi
Heat Soak	0 psi	20 psi
Fuse	72 psi	95 psi
Cool	0 psi	0 psi

Logged Data Summary

Number of Data Points	80
Total Fusion Time	357 seconds
Maximum Recorded Pressure	82 psi
Temperature(external probe)	421 °F

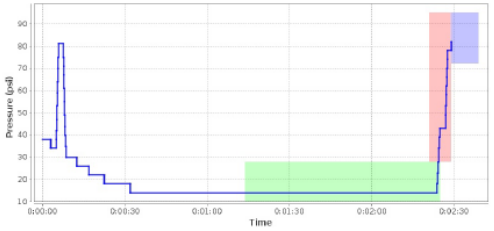
Device Information

DataLogger Serial Number	MDL4-0451
Calibration Date	2022-02-21
Firmware Version	v0.8
Software Version	v1.1.6
Software Product Name	DL4m

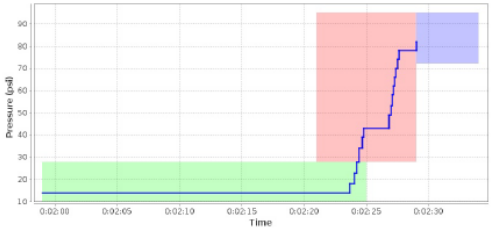
Data Source

File Name	DL4 2022-10-11 at 11-42-09 Joint 6 Job Offut AFB by Training.DL4
Upload Time	2022-10-11 16:56:24 GMT

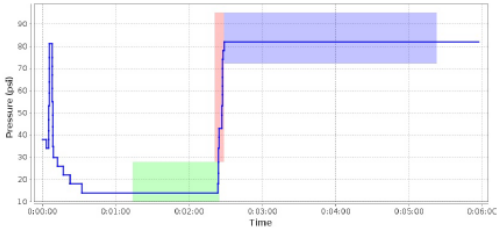
Front-end Plot



Heater Removal Plot



Summary Plot



Notes

training

Shareable joint report summary is stored securely in the Vault

Datalogger

HDPE Rehabilitation Methods

- Sliplining
- Swage – Lining
- Pipe Bursting

HDPE Rehabilitation Methods

Sliplining and Swage-lining require the pipe to be scraped clean and videoed

https://www.facebook.com/pepipeorg/videos/693671912767307

Sliplining

- Pushing a new pipe inside an existing conduit
- Loose fit
- Better hydraulics allow for smaller ID

Swage- Lining – Compression Fit

- Pipe is pulled through a compression ring
- Kept under tension during entire installation
- Reverts to original OD after tension is released

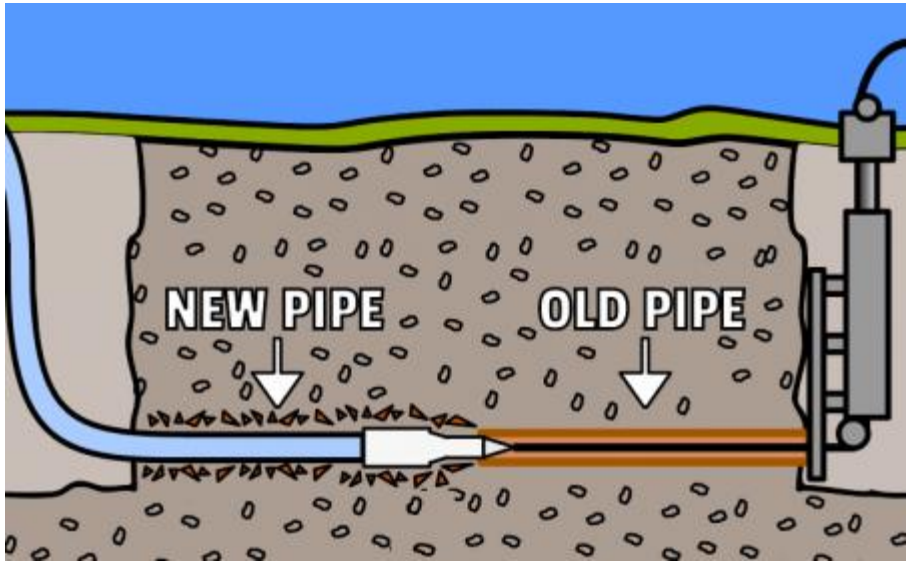
Swage-Lining – Compression Fit

Pipe Bursting (Fracturing)

A trenchless method used to replace underground pipes, typically by shattering the old pipe and pulling in a new High-Density Polyethylene (HDPE) pipe.

HDPE pipe is the preferred material due to its flexibility, durability, and ability to be installed in long, continuous lengths.

Pipe Bursting



This method is often used for replacing aging or damaged water and sewer lines, minimizing disruption to the surrounding environment and infrastructure.

Pipe Bursting Advantages

- ✓ Uses an Existing Conduit
- ✓ Increased Hydraulic Capacity
- ✓ Corrosion and Chemical Resistance
- ✓ Long Lifespan
- ✓ Flexibility and Durability

The Pipe Bursting Process

Camera Inspection

Identify Entry and Exit Points

Install a Bypass Line if Needed

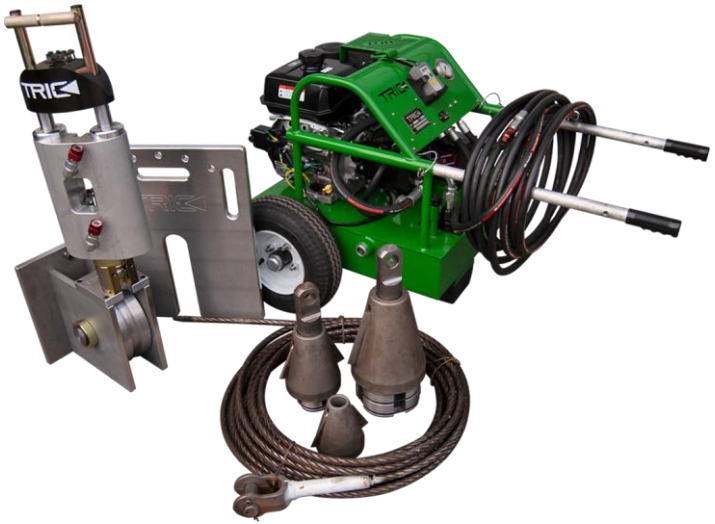
Weld New Pipes Above Ground

Pressure Test, Disinfect

Burst Old Pipe by Pulling New Pipe Through

Commission the New Line

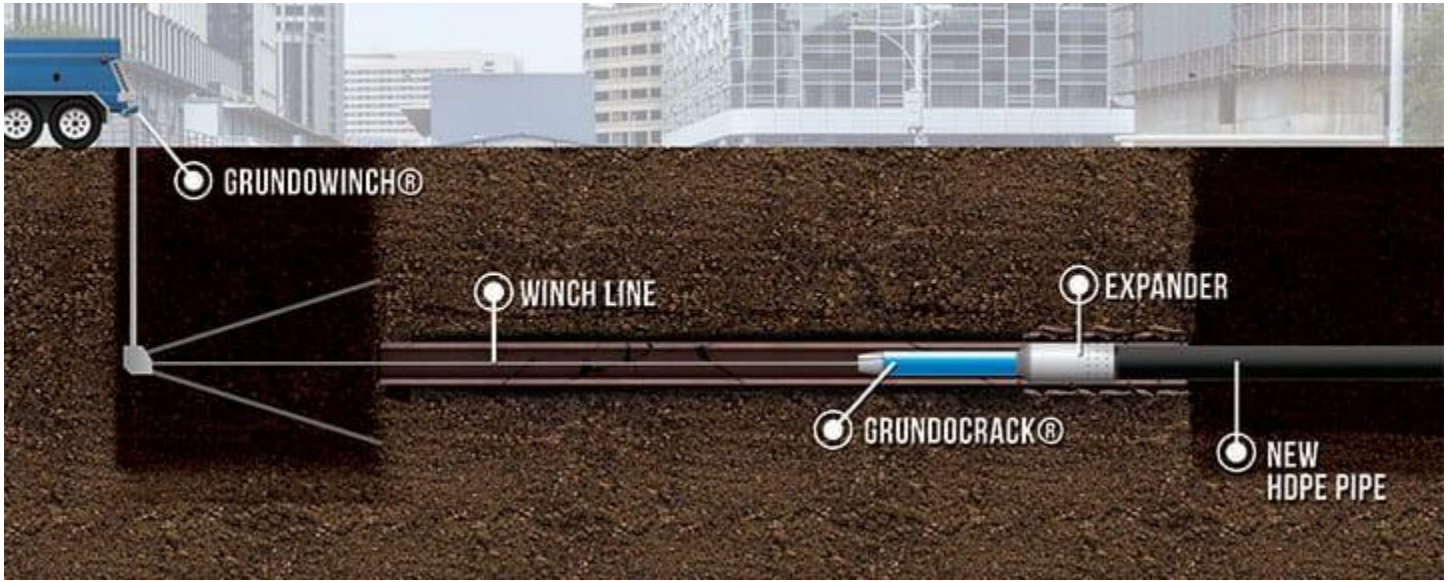
Types of Pipe Bursting



Static/Hydraulic

Static/Hydraulic Pipe Bursting

Types of Pipe Bursting



https://www.youtube.com/watch?v=S8-a9lJ6clk

Pneumatic

Hydrostatic Testing

- Purpose of Test
- Water vs. Air
- Pre-test Prep
- Procedures per ASTM F2164
- Hydraulic pressure safety topics

Why Water vs. Air for Testing?

- **Air is very compressible – hydraulically equivalent to a giant spring**
- **Water is incompressible**
- **Water best serves the test purpose – checking for leakage**

Why is HDPE Different than PVC/DI?

- **HDPE pipe reacts to temperature**
- **HDPE pipe reacts to pressure**
- **Testing must allow for these changes**

What is the Poisson effect in pipe?

When pipes such as polyethylene pipe are pressurized, the diameter will expand slightly, and due to the Poisson effect, the pipe will shorten in length.

Hydrostatic Test Procedure

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F2164 – 18

Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure[1]

This standard is issued under the fixed designation F2164; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

Test Section

Entire System
or
Smaller Test Sections

- **Match water availability**
- **Equipment used**
- **Time constraints**

Ambient/Pipe Temperature

Pipe is rated at 73F

Higher temps = lower pressure class

Often best to test in morning

Test Pressure

Determined by project owner/engineer

Typically 1.5 X system pressure

Do not exceed the pressure rating of lowest pressure rated component in the system.

Filling the Test Section

Fill slowly

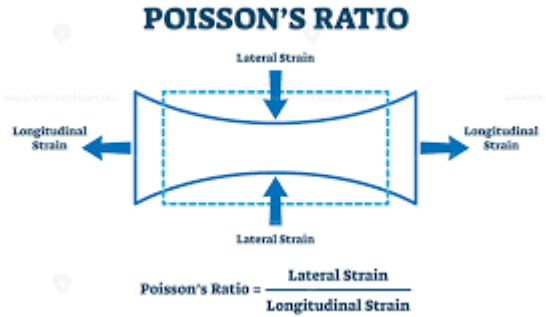
Purge all air – trapped air is dangerous

Don’t fill faster than venting capacity

Allow test section and test liquid equalize temp

Initial Expansion Phase

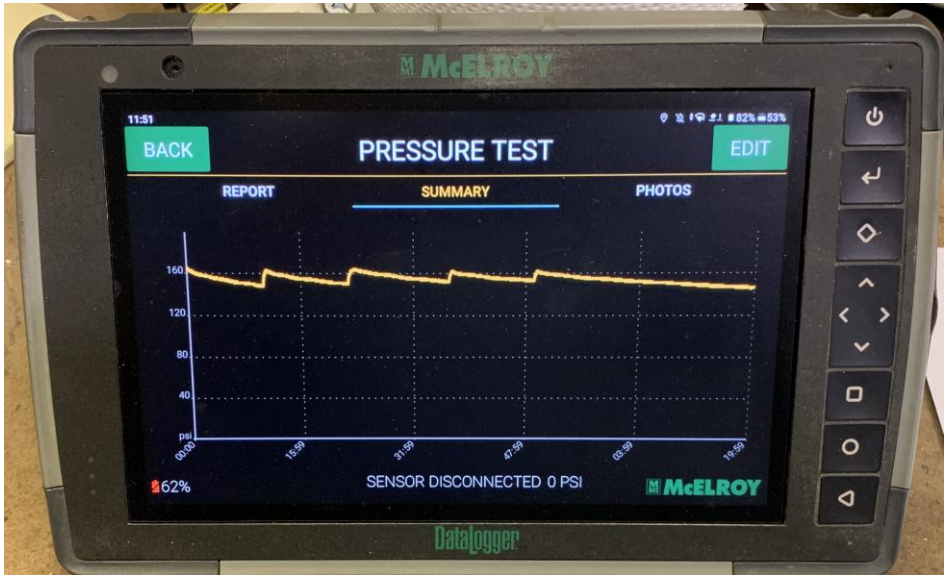
Gradually increase pressure to required test pressure.



When test pressure is applied, polyethylene pipe will expand slightly due to elasticity and Poisson effects.

Add Make-up Water

After initial pressure drops, add make-up water to maintain maximum test pressure for 4 hours



Test Phase

Reduce test pressure by 10 psi

Monitor pressure for one hour

Do not add water or increase pressure

Pass/Fail Criteria

No visual leakage

Pressure remains steady (within 5% of test phase pressure)

Adding Service Saddles

- Saddles can be added to the main with Sidewall Fusion or Electrofusion

- Mechanical saddles are also available and are used with great success

Pressure Testing of Saddles

- A test cap is secured to the saddle outlet
- Unscrew self tap and screw on a pressure gauge
- Connect to water pump, purge air, hold at test pressure for required time

So, What do you see?