Transient Pressure Monitoring in Force Mains

Thursday, December 1, 2016

Defining Why…

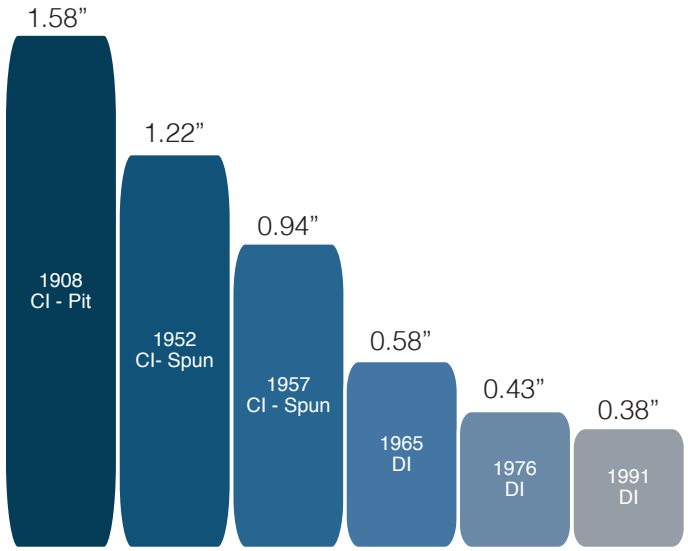
Infrastructure is the backbone of modern society. It enables everyday life.

Through understanding the true condition of buried infrastructure, resources can be effectively focused with precision, prolonging asset life, improving safety and increasing reliability.

Why Not Just Replace?

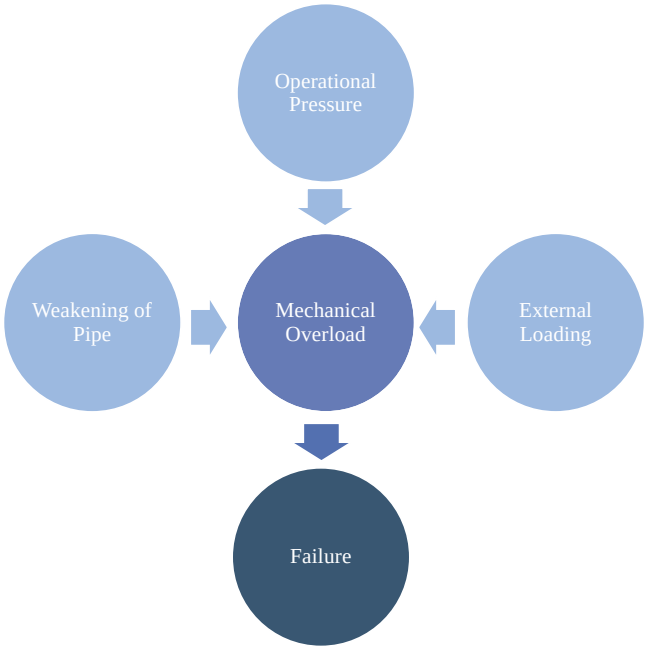
- Bases for replacement programs are conservative
- High risk often driven lack of or poor data quality
- Age rarely correlates with condition

Age is a Poor Indicator Of Condition



36-inch Diameter – Pressure Rated for 150 psi

Why Do Pipes Fail?

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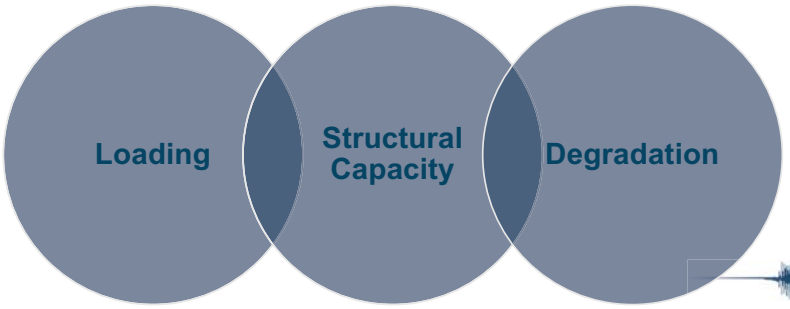
*No **single** technology or technique can identify **all** of the indicators of pipe deterioration.*

*Therefore, a **holistic**, risk based approach should be used.*

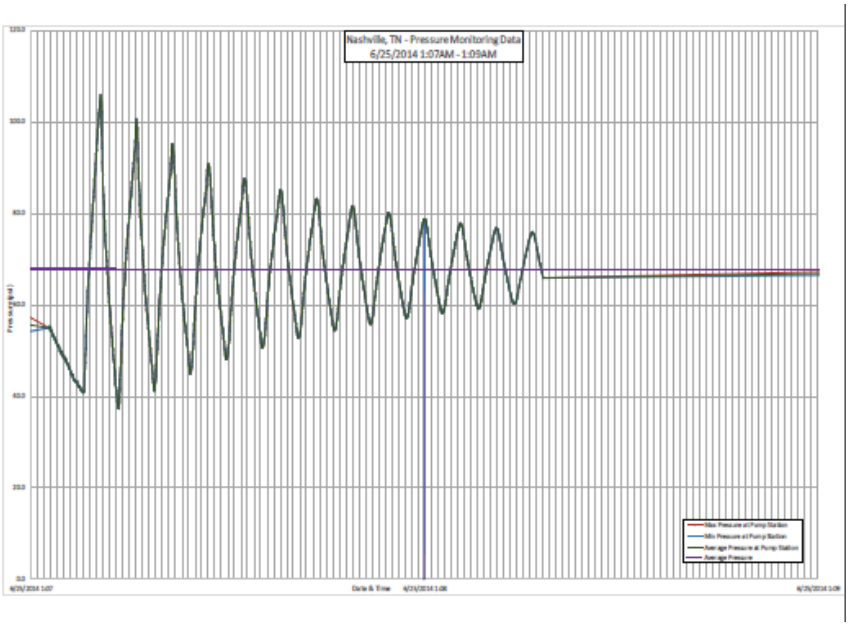
Likelihood of Failure



What is a Pressure Transient?

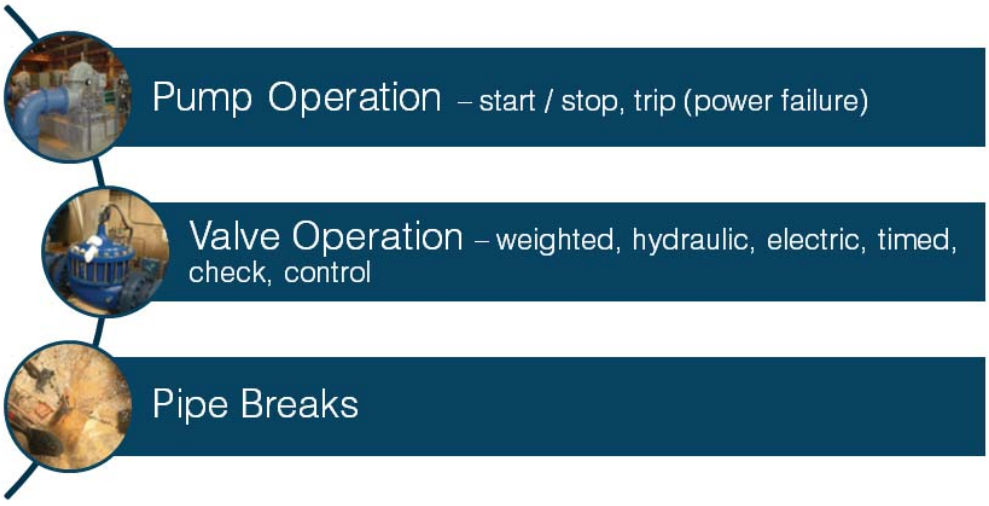
$$c = \frac{1}{\sqrt{\rho\left(\frac{C_1 D}{tE} + \frac{1}{K}\right)}}$$

c = Acoustic wave speed (m/s)
E = Young's modulus of pipe material (N/m²)
K = Bulk modulus of fluid (N/m²)
ρ = Fluid density (kg/m³)
D = Pipe diameter (m)
t = Pipe wall thickness (m)
C_1 = Constant depending on pipe anchorage



Background

What causes transients in pipe networks?



Background

What's so bad about transients?

Transient pressures can cause damage by:

- Exceeding design pressure
- Structural fatigue where the transient is recurring
- Exceeding structural capacity with current level of deterioration
- Negative pressures

Transient pressures can create water quality issues:

- Contamination through ARVs and breaks

Background

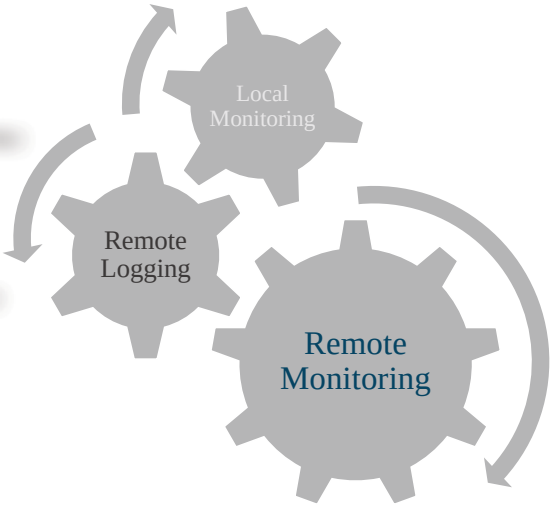
State-of-the-Industry
Nothing to well established SCADA Monitoring

Best Practice
Optimized Pressure Monitoring – far reaches of the system, extreme pressures (max. & min.)

State-of-the-Art
Transient Pressure logging and manual data retrieval at accessible locations

Some real-time monitoring at remote locations

“Smart Network” – well distributed, wireless, real-time, transient capable pressure monitoring



Background

Don't Utilities already monitor pressure with their SCADA systems?

Yes, however, most current SCADA systems have two limitations:

- *Resolution (Sample Frequency)*
- *Location*

Don't Utilities design pipelines and facilities to address transient issues?

Yes, however, things change:

- *Equipment ages and/or breaks*
- *Operating conditions change*
- *Pipes deteriorate*

Typical Hardware

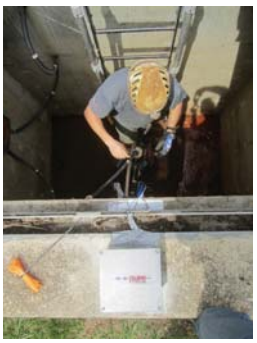
Equipment	Wireless	Transient Capable	Max. Sample Rate	Mounting / Connection	External Antenna	Transient Trigger Parameters
Telog LPR-31i	No	Yes	20 Hz	¼” NPT	N/A	Pressure & Time
Telog HPR-31i	No	Yes	20 Hz	2.5” NHT	N/A	Pressure & Time
Telog HPR-32	Yes	No	4 Hz	2.5” NHT	No	N/A
Telog RU-32	Yes	No	4 Hz	¼” NPT	Yes	N/A
Telog (Trimble) PR-32i	Yes	Yes	32 Hz	¼” NPT	Yes	Pressure & Time
Telog (Trimble) HPR-32i	Yes	Yes	32 Hz	2.5” NHT (Hydrant) & ¼” NPT	No	Pressure & Time
Syrinix PipeMinder-S	Yes	Yes	128 Hz	Hose - 21KA quick release	Yes	Unit less Sensitivity Setting
Syrinix PipeMinder-C	Yes	Yes	128 Hz	21KA quick release	Yes	Unit less Sensitivity Setting
Pipeline Technologies TP-1	Optional Cellular	Yes	100 Hz	Variable	Optional	
Pipeline Technologies TP-3	Yes	Yes	Up to 1000 Hz	Variable	Optional	

Installation







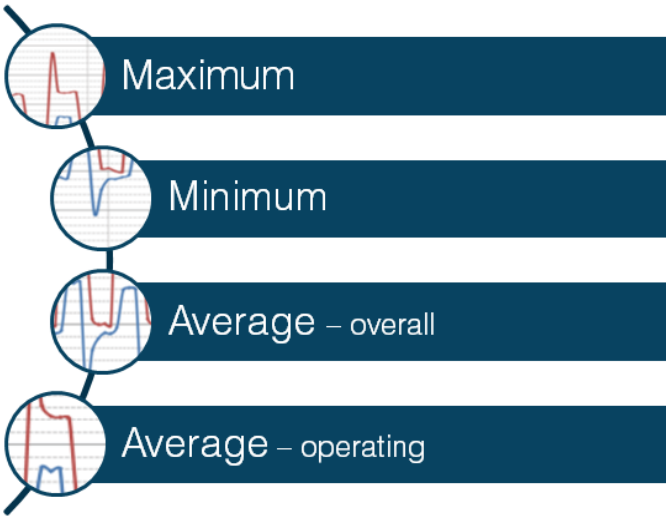



Transient Monitoring

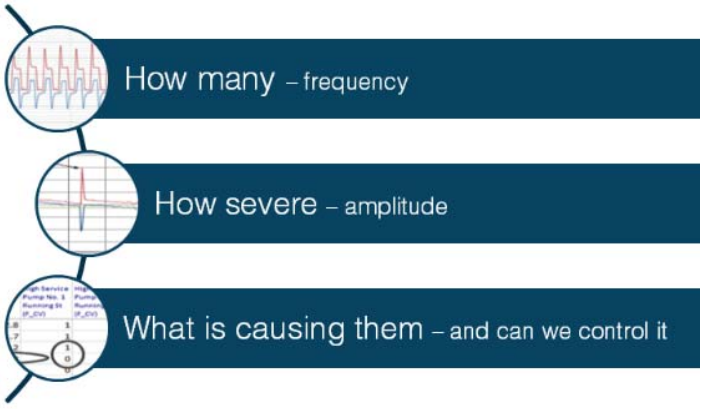
Approach

What do we want to know?

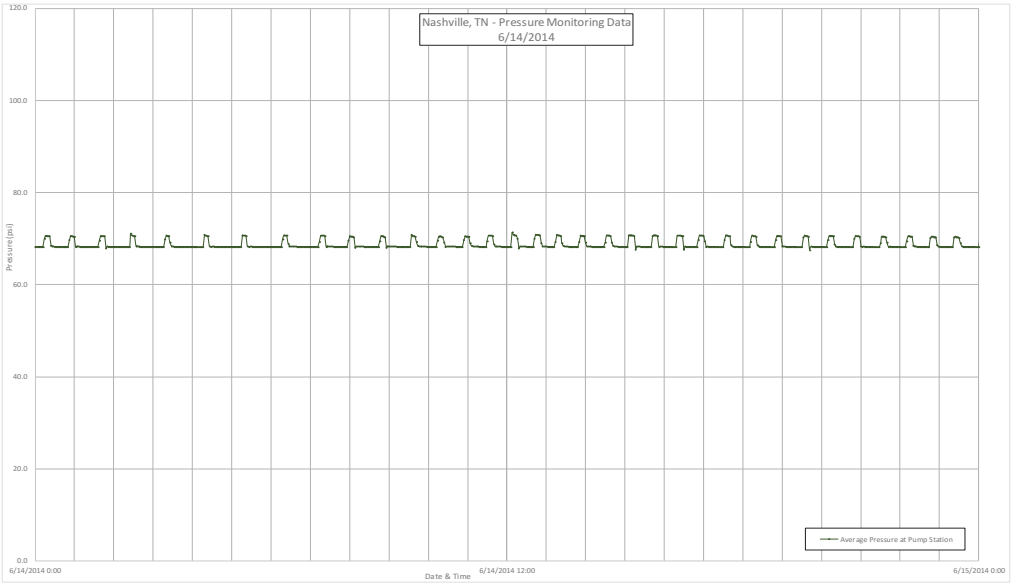
What pressures is the pipeline (really) experiencing?



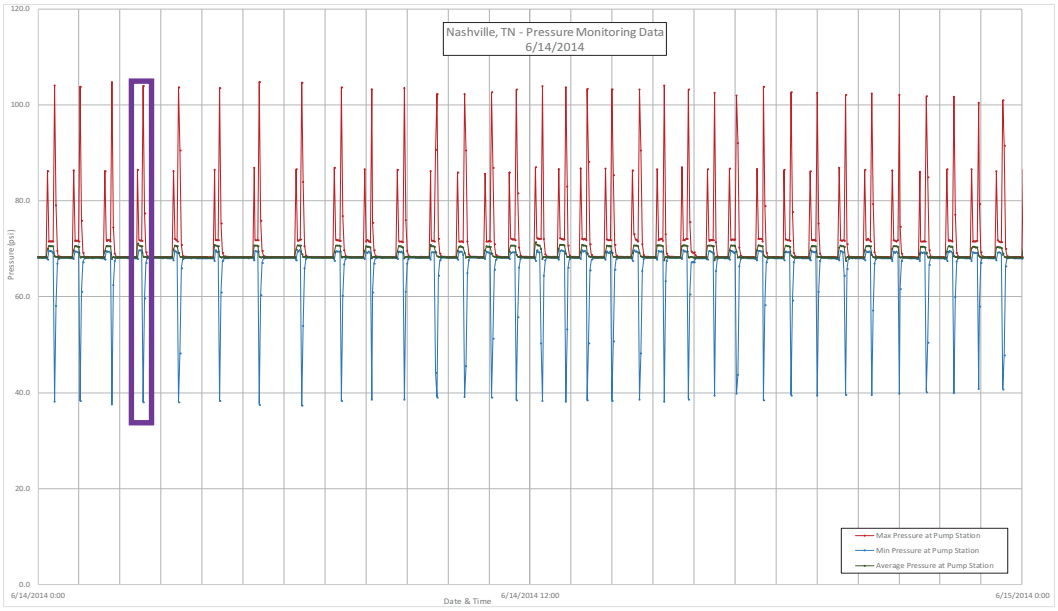
Are there recurring transient pressures?



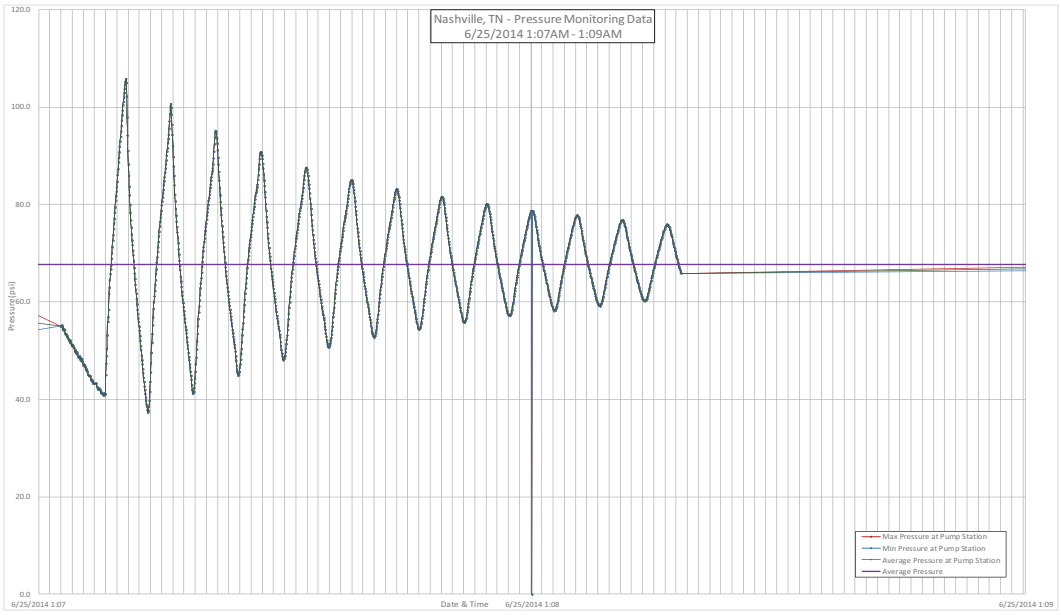
Nashville, Tennessee – SCADA Pressure



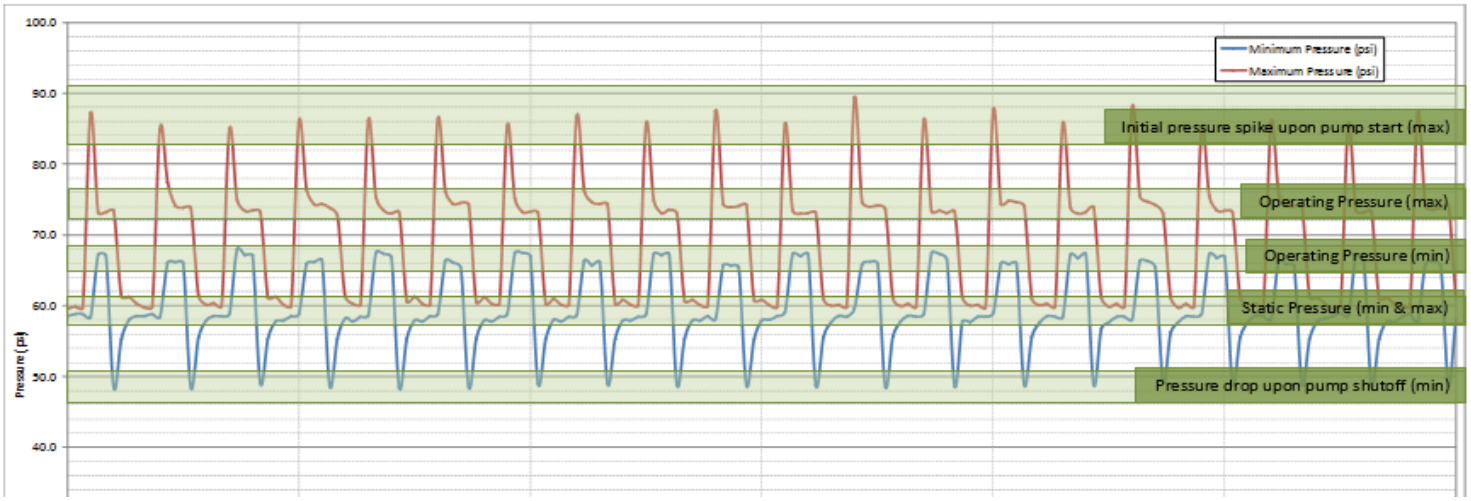
Nashville, Tennessee – Transient Pressure Monitor



Nashville, Tennessee – Individual Transient Signal



What Data Do We Need?



Transient Analysis

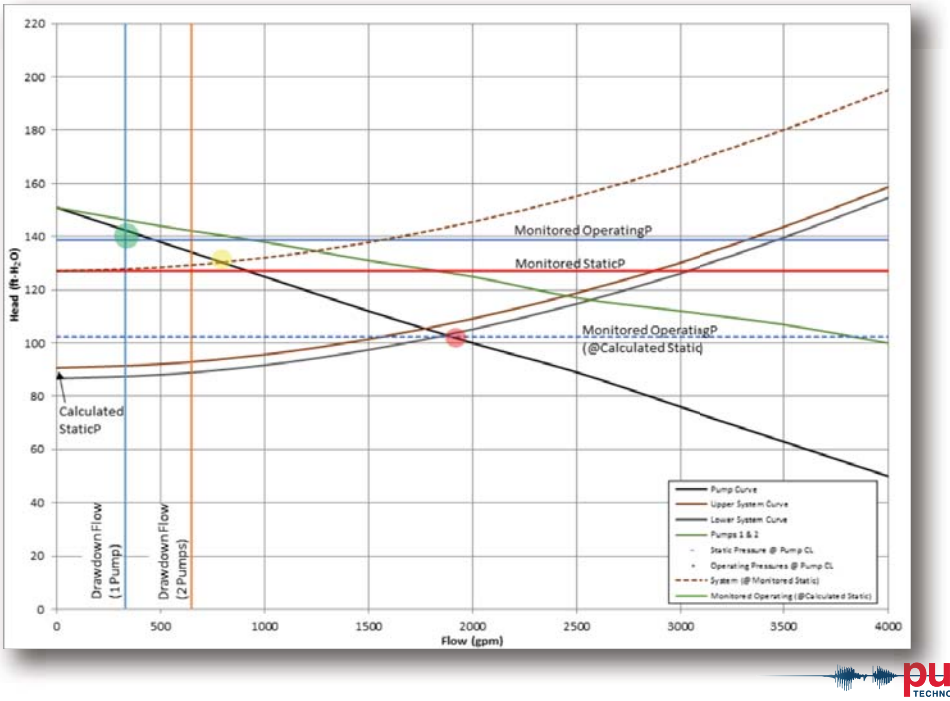
Reducing Risk and Increasing Life

Real-time Structural Fatigue for PVC

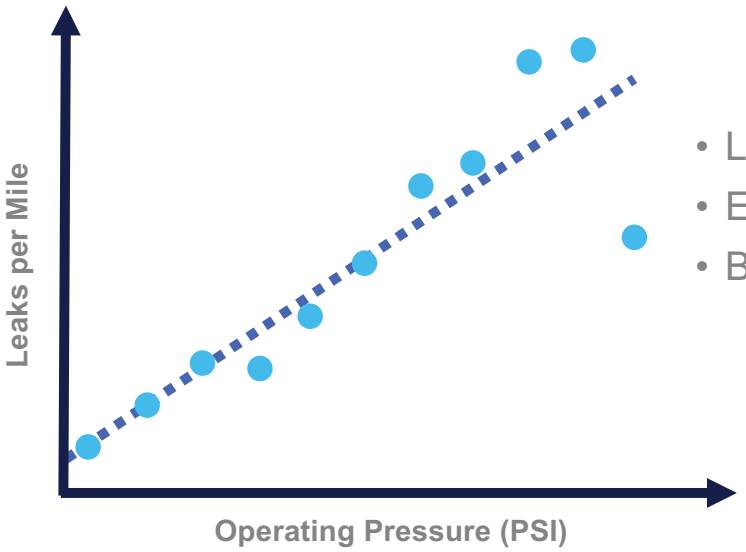
Years to Failure Before New ARV Installation
30

Years to Failure After New ARV Installation
118

Pump and Force Main Operations



Pressure & Leaks/Breaks



- Lower potential of failures
- Extend the life of pipelines
- Better pump operation

Source: Colorado Springs, Colorado

MSD Force Main Evaluation Program

- *MSD serves approx. 1.3 million people, over 525 square miles*
- *2012 Consent Decree required the creation of a Force Main Evaluation Program (FMEP)*
- *Under this program, condition assessment plans for all high and medium risked force mains were developed.*

FMEP: Risk Based Assessment

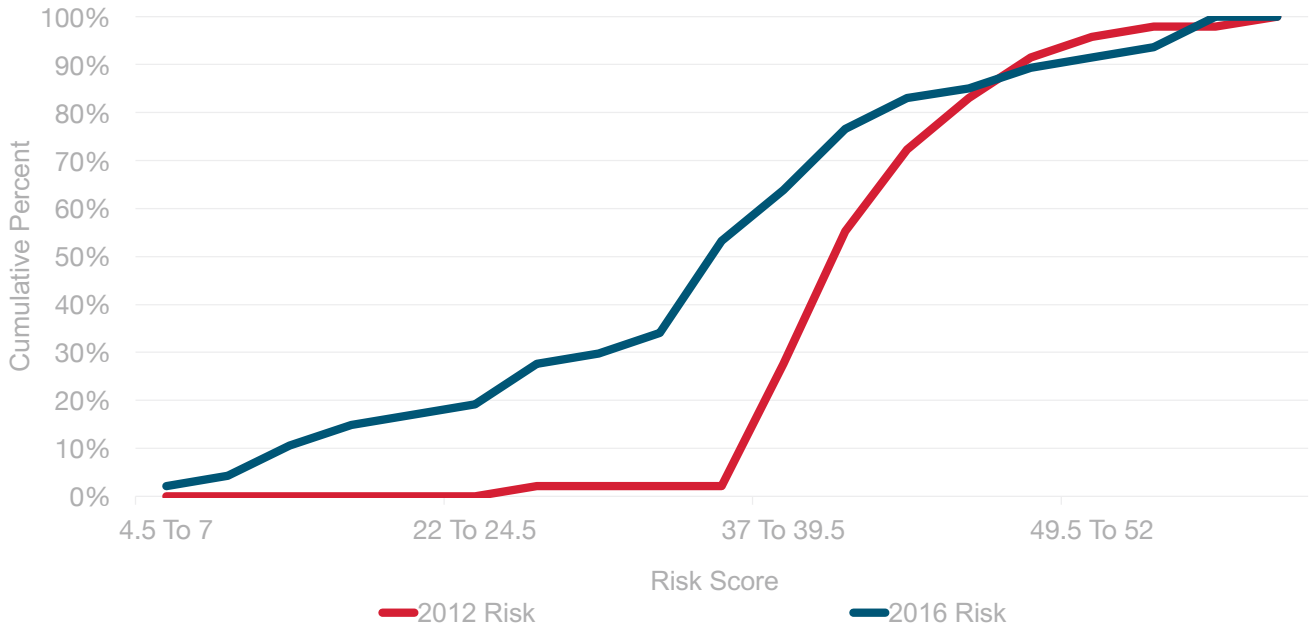
Technology Approach

- TPM
- Internal Corrosion Screening
- Soil Surveys

- Ultrasonic Testing
- Impact Echo
- Electromagnetics

- Structural Analysis
- Remaining Useful Life

A Sustainable Program



Repair vs. Replace

Less than 10% of pipelines surveyed have indicators of distress,
while even fewer require repair or replacement to extend their useful life

10%

The cost of condition assessment can be less than 8%
of the cost of full-scale replacement programs

8%

Future of TPM

- Break detection and notification
- Pressure sensor design and layout
- Energy conservation
- Advanced statistical analysis

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