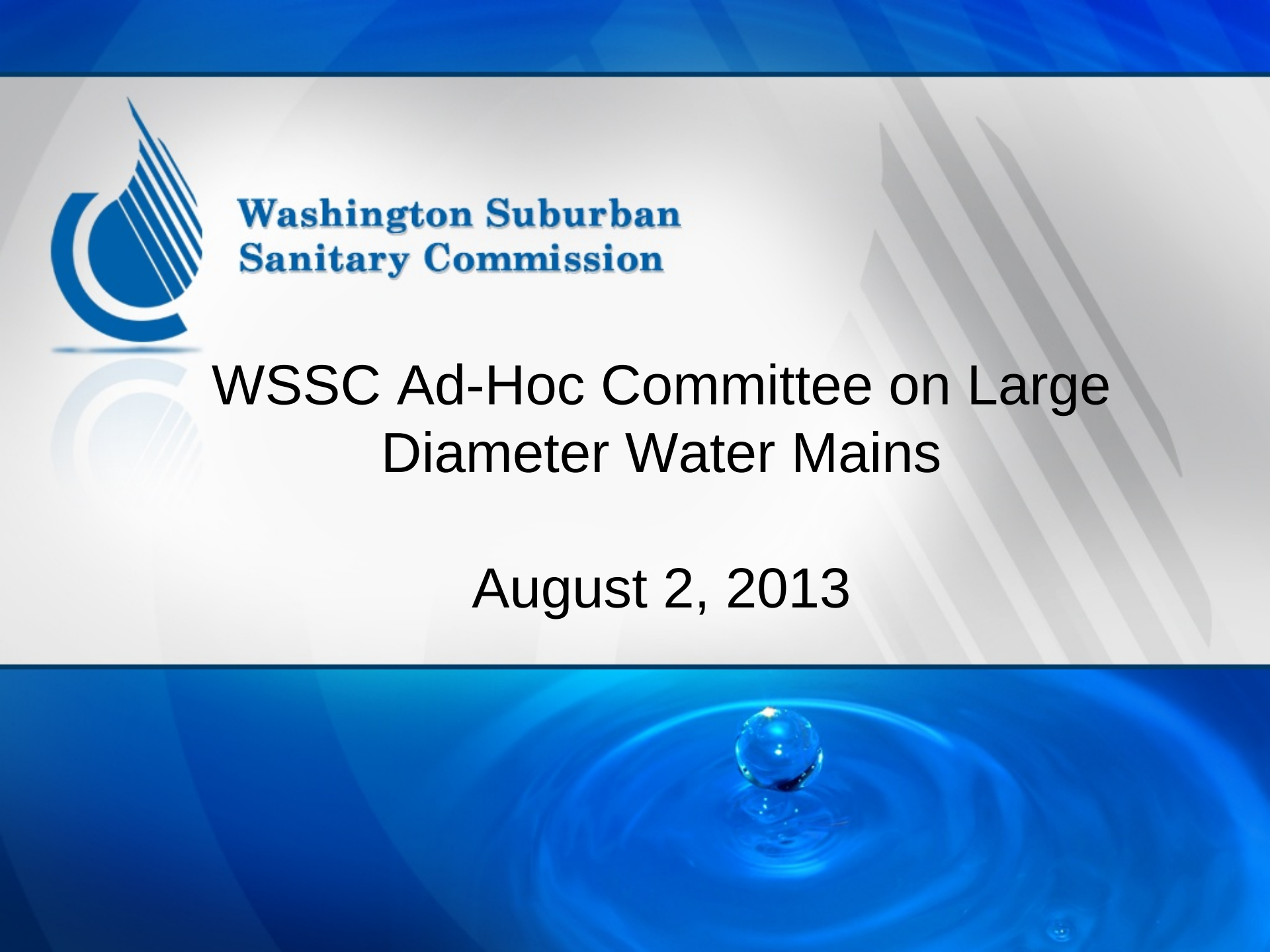
Washington Suburban Sanitary Commission

WSSC Ad-Hoc Committee on Large Diameter Water Mains

August 2, 2013



Purpose:

To Gain an Understanding of WSSC's Current Approach to PCCP Inspections, Monitoring and Repair/Replacement

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PCCP Management Program

PCCP Management Program:

- An Asset Management Strategy for 36-inch and Larger PCCP Water Transmissions.
- Program First Established in Early 1980's.
- In 2007, WSSC Initiated the Current Program Strategy using a 5-Year Inspection Plan.

Program Objectives:

- PCCP Pipeline Condition Assessment and Monitoring for Maintenance Repairs and Long Term Capital Planning.
- Ensures Timely Routine Inspection and Repairs.
- Ensures the Pipelines Reach Their Useful Life.
- Provides Safer, More Reliable Water Supply.

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Focus of PCCP Management Program

PCCP Management Program Focus

- WSSC has 357 Miles of Pre-Stressed Concrete Cylinder Pipe (PCCP) Water Mains.
- Program Focuses on 145 Miles of 36-inch and Larger Which Includes:
  - 77 miles – 48” and Greater
  - 68 miles – 36” and 42”

Inspection Goals and Intervals

- Annual Inspection Mileage Goal is Currently 18 miles. By the end of 2013, all Pipelines 48-inch and Larger will have been Inspected, Repaired and Equipped with AFO monitoring.
- Majority of PCCP Water Mains 54-Inch and Greater have been Inspected Between 1 to 3 times and a few of the more Problematic Mains have been Inspected 4 to 5 times.
- Mains 48-inch and Larger are on a 5 to 7 Year Inspection Cycle Depending on AFO Wire Break (WB) Data.
- Inspection of Mains 36 and 42-inch Began in 2013 and are on an 8 to 10 Year Inspection Cycle also Depending on AFO WB data. They will also be Equipped with AFO Monitoring Following Inspection.

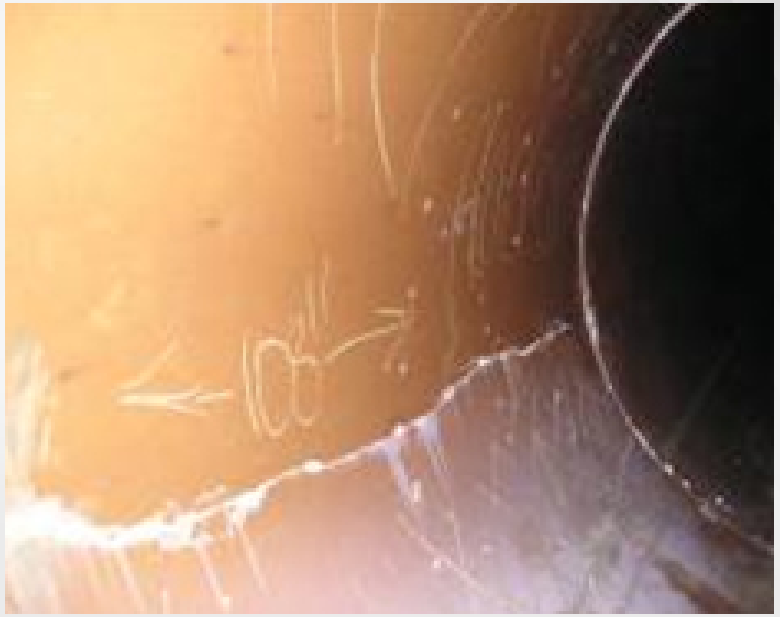
Program Logistics

- Timing: Internal Inspections are Typically Performed During Periods of Lesser Water Demand Between October through May.
- Inspections: Mains 48-inch and Larger are Manned and Require Complete Pipeline Dewatering. Mains 36 and 42-inch are Robotic and can be Done Fully Pressurized or Partially Dewatered.
- Testing Methods: Mains 48-inch and Larger Includes Visual and Sounding, Sonic/Ultrasonic, Electromagnetic, and Acoustical Leak Testing. Mains 36 and 42-inch Includes Visual if Not Pressurized, Electromagnetic and Acoustical Leak Testing.
- Repairs/Replacements: Damaged Pipe Sections are Either Repaired or Replaced Prior to Placing Main Back in Service.
- Acoustical Fiber Optic Monitoring (AFO): Permanent AFO Monitoring Installed to Detect Wire Break Activity in Mains 36-inch and Larger.

Visual and Sounding 48-Inch and Larger

Visual and Sounding: (48-inch and Larger)

- Pipe Numbering for Documentation and AFO Monitoring, Lay Schedule.
- Visual Inspection for Defects.
- Sounding Inspection for Hollows.



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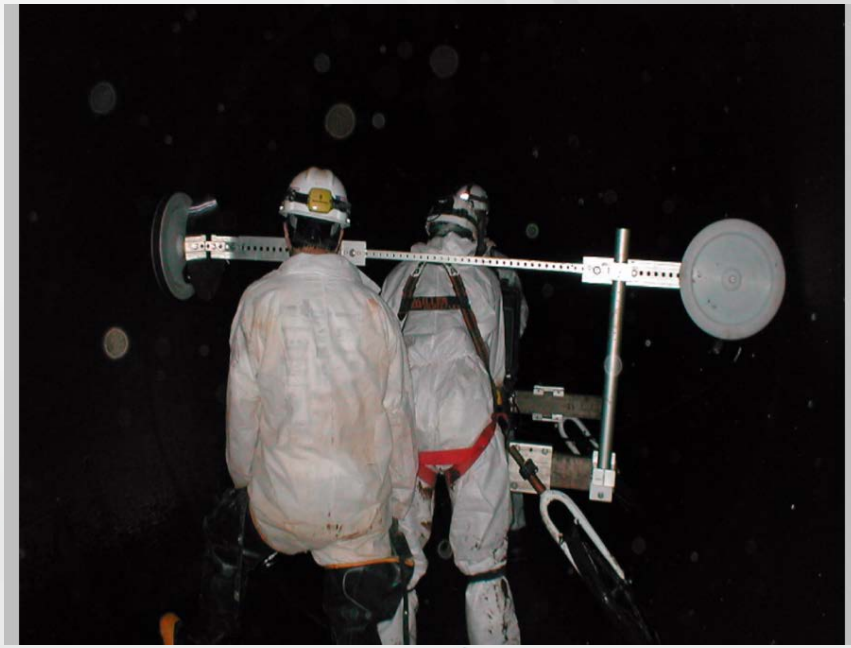
Manned Electromagnetic 48-Inch and Larger

Manned Electromagnetic Testing: (48-inch and Larger)

- Locate/Estimate the Number of Broken PCCP Wires
- Establish Baseline for AFO Monitoring



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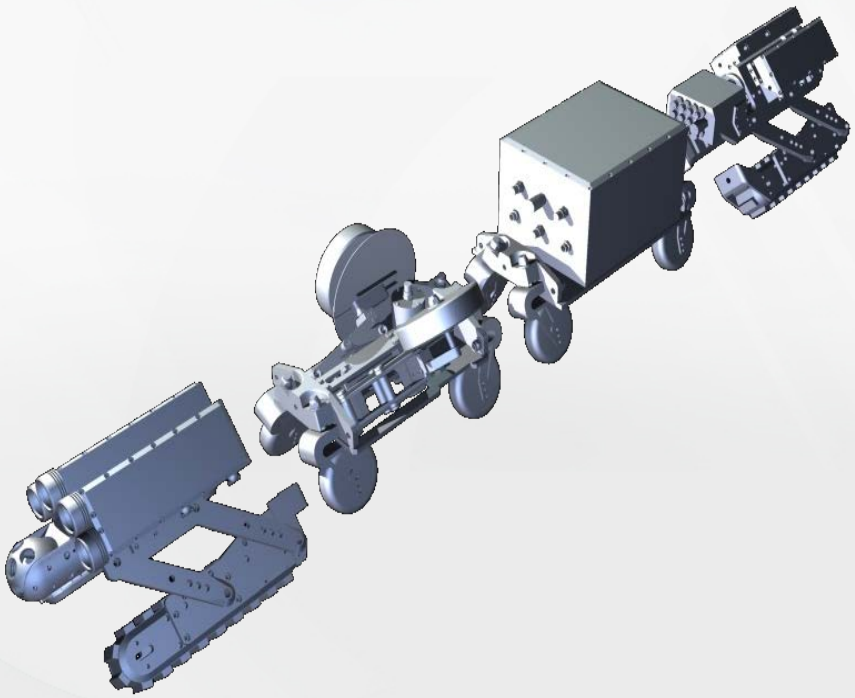
Robotic (Crawler) Electromagnetic 36 and 42-inch PCCP

Robotic Crawler Electromagnetic Testing: (36 and 42-inch)

- Locate/Estimate the Number of Broken PCCP Wires.
- Establish Baseline for AFO Monitoring.
- Includes Visual Camera Inspection.
- Partially Dewatered Main.



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Robotic (Free-Floating) Electromagnetic 36 and 42-inch PCCP

Robotic (Free-Floating) Electromagnetic Testing: (36 and 42-inch)

- Locate/Estimate the Number of Broken PCCP Wires.
- Establish Baseline for AFO Monitoring.
- Does Not Include Camera Inspection.
- Fully Pressurized Main.

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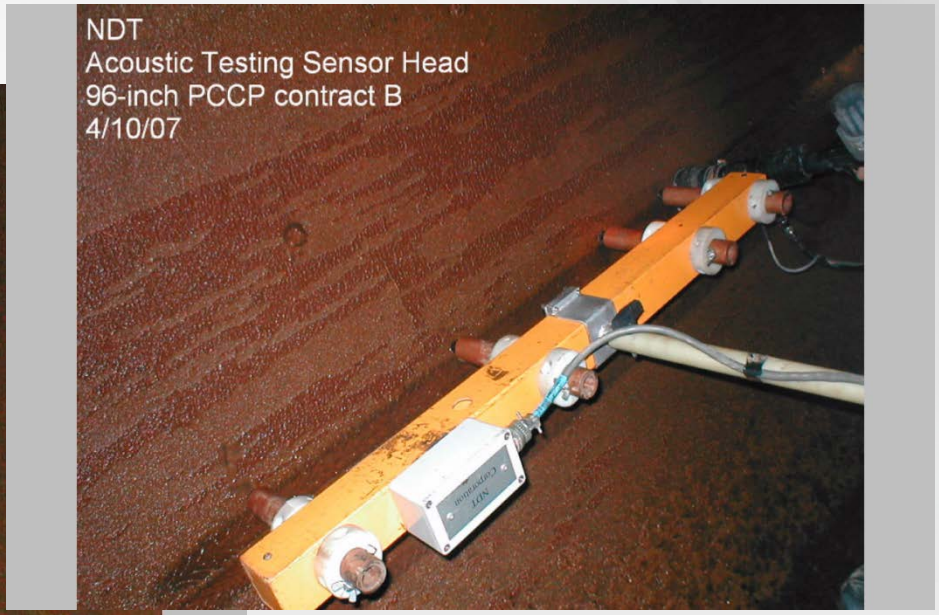
Sonic/Ultrasonic Testing 48-Inch and Larger

Sonic/Ultrasonic: (48-inch and Larger)

- Locate Delamination, Poor Pipe Composite, Concrete Defects.
- Run in Parallel to Electromagnetic.
- Follow-up Detailed Testing.

NDT
Acoustic Testing Crew
96-inch PCCP contract B
4/10/07



NDT
Acoustic Testing Sensor Head
96-inch PCCP contract B
4/10/07

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SmartBall - Acoustical Leak Testing

Acoustical Leak Testing: (36-inch and Larger)

- Deployed/Retrieved in Pressurized Main – Free Floating.
- Requires all Branch Valves to be Closed.
- Pinpoints Acoustical Leaks.
- Leaks Repaired Following Main Dewatering.

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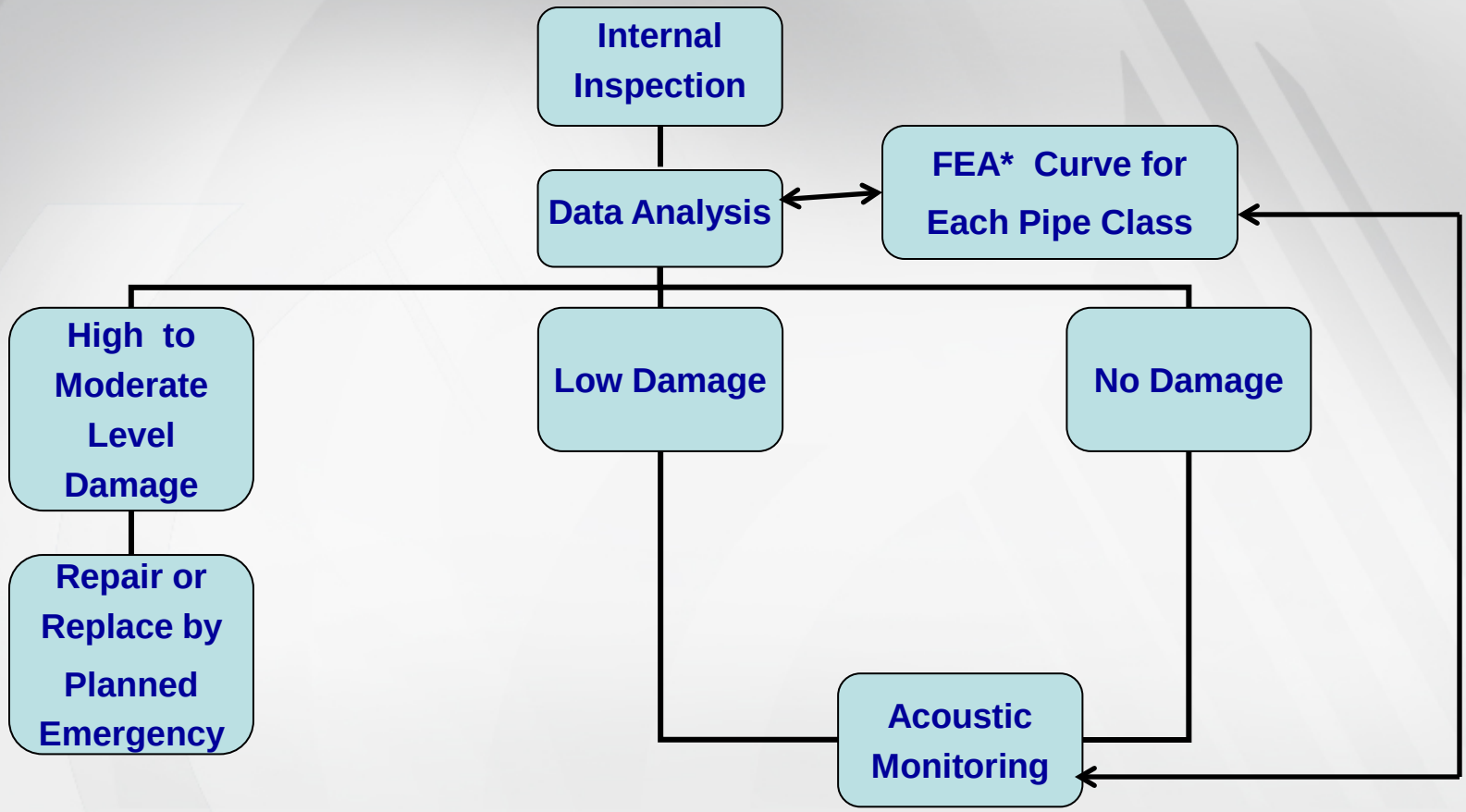
Actions Following Inspection



* Finite Element Analysis

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Repairs or Replacements Following Inspection

- The Pipe Sections Found with a High to Moderate Level of Damage as Determined by the Finite Element Analysis Curve are Repaired or Replaced.
- Repair versus Replacement is Based Primarily on Location of Pipe for Excavation.
- <u>Replacements:</u>
  - Ductile Iron or PCCP Repair Kit used for Pipe Sizes 54-inch and Below.
  - PCCP Repair Kit used for Greater than 54-inch (Non-DIP Sizes).
- <u>Repairs:</u> Primarily Internal with Full Stand Alone Carbon Fiber Composite.
- All Repairs and Replacements are Permanent for the Life of Pipeline.

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Internal Repair with Carbon Fiber Composite

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PCCP Replacement with PCCP Repair Kit

PCCP Repair Kits are Not Pre-Stressed Pipe – Made of Steel Pipe with Concrete Encasement

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PCCP Replacement with Ductile Iron Pipe

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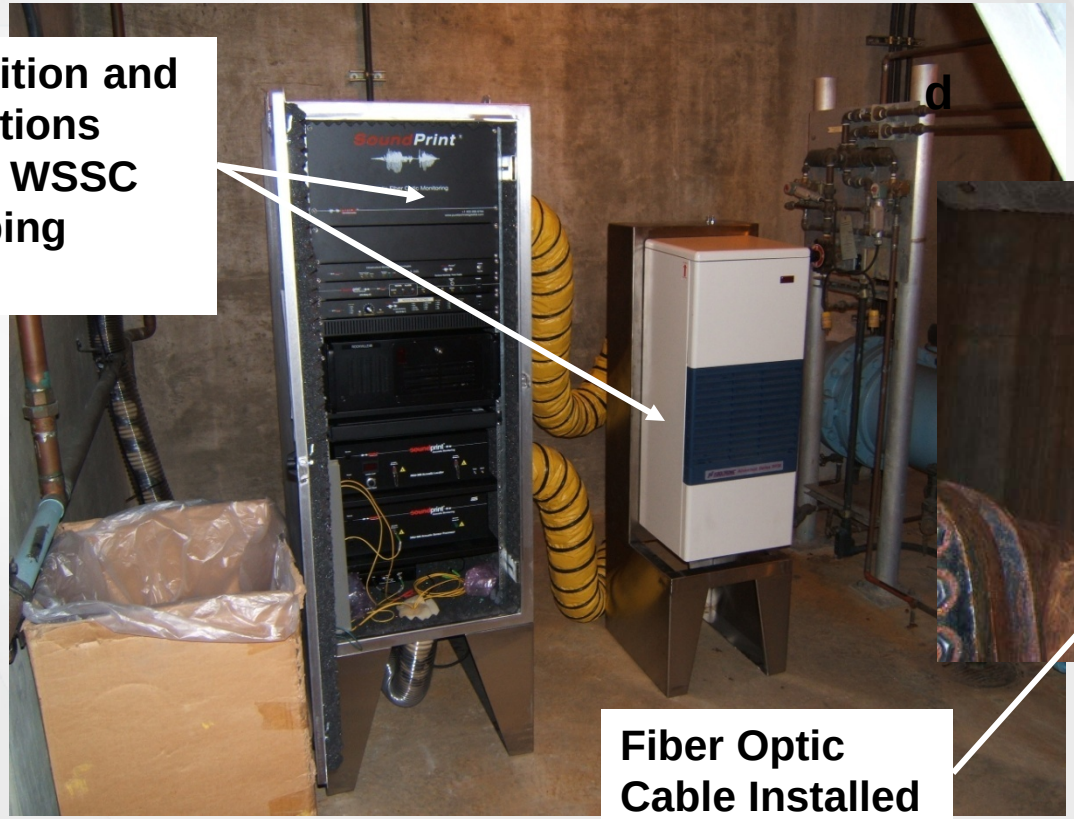
Acoustical Fiber Optic Monitoring

- AFO Monitoring Installed Following Pipe Repairs/Replacements.
- Requires Electric Power and Communication Line for Data Reporting.



Data Acquisition and Communications Cabinet in a WSSC Water Pumping Station

Fiber Optic Cable Installed Inside Pipe

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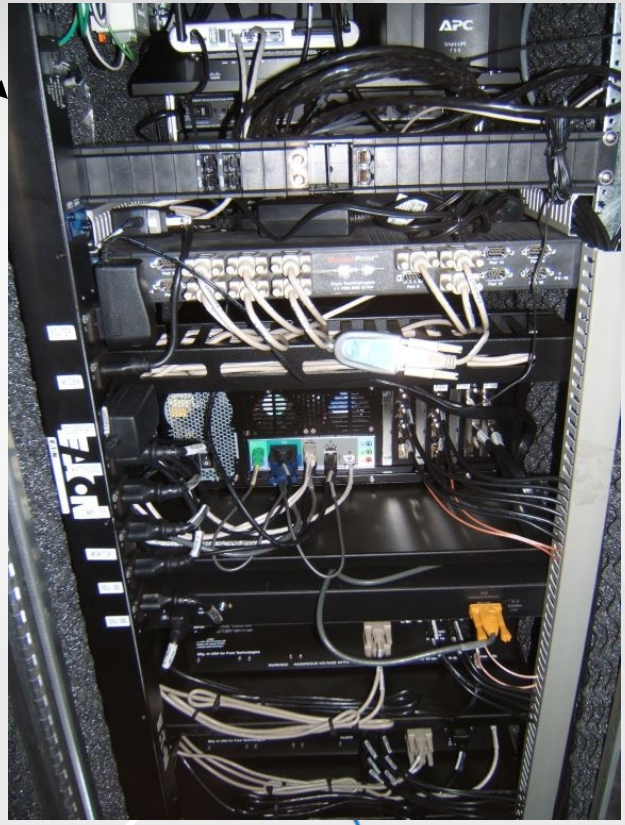
Acoustical Fiber Optic Monitoring

Data Acquisition and Communications Wire/Power Connections

Back of Data Acquisition Unit



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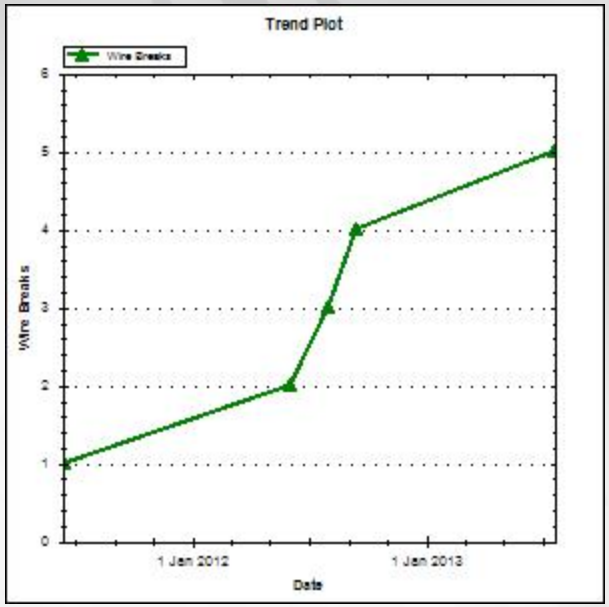
Electronic Wire Break Alert

The SoundPrint® Data Processing Center has classified a Wire Break event for the monitoring station at WSSC-PAFO48.

Event Data	
Site:	WSSC-PAFO48
Date / Time:	Jul 17, 2013 00:56:47 Eastern Standard Time
Event Classification:	Wire Break
Location:	PFO48 (13) 66-2621 Station # 4+87
Pipe Data	
Pipe Diameter:	48 "
Pipe Class:	PCCP
Repaired:	No
Replaced:	No
Inspected (Electromagnetic):	Dec 10, 2010
Charts and Maps	
Project Overview Map:	Pipe Location Maps
Zoomed Location Map:	Are Not Shown



61-12	61-13	61-14
PCCP	PCCP	PCCP
0+0=0	0+5=5	0+0=0
0	5	0
4+90.64	4+86.88	4+77.21

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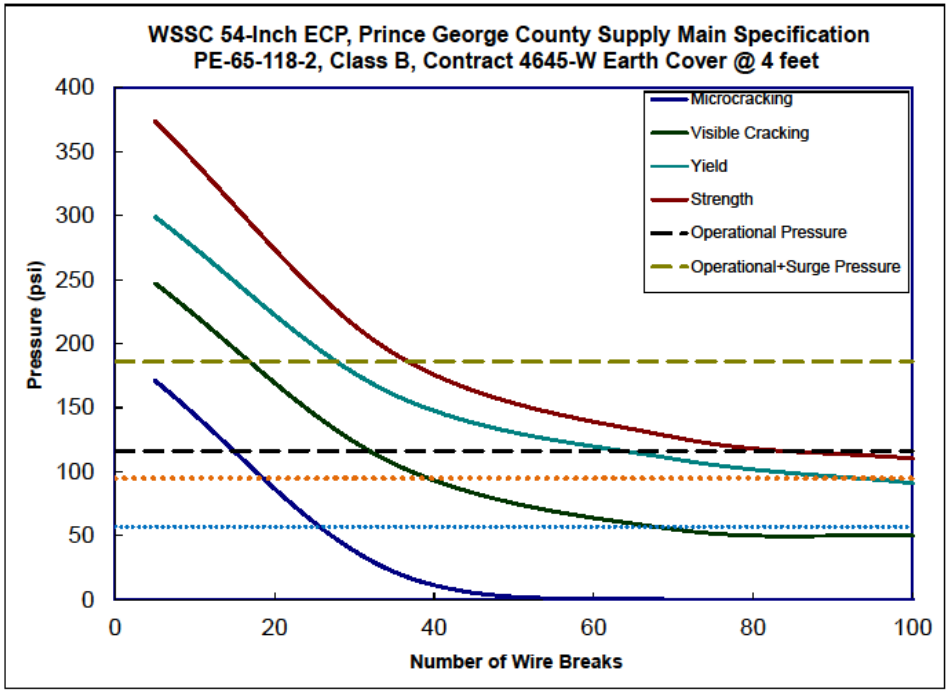
AFO Wire Break Data Analysis

Data Analysis Process:

- Acoustical Wire Breaks Go Directly to Pure Technologies Calgary Office for Analysis.
- Baseline Wire Break Count added to AFO Wire Breaks.
- Compared to FEA Curve for that Pipeline.
- No Concern: No Action
- Concern: WSSC is advised by Pure Technologies of Recommended Action.



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Acoustical Fiber Optic Monitoring

- What Does it **Do**?
  - Monitors Acoustical Pre-Stressed Wire Break Activity.
  - Coupled with Baseline Determines Rate of Deterioration.
  - Used to Prioritize/Adjust PCCP Inspection Schedule.
  - Provides Advance Notice of Pending Pipe Failure to Initiate Proactive Response.

- What Does it **Not Do**?
  - Prevent Deterioration.
  - Monitor for Pipe Leaks.
  - Guarantee a Pipe Will Not Fail.

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How do the Pipes Fail?
What are the Causes of Failures?

- PCCP Pipe Fails Catastrophically Typically as Result of Long Term Deterioration or a Compromise of the Composite Pipe Structure.

Common Causes of PCCP Failure:

- Most Common Failure Mechanism: Pre-Stressed Wire Corrosion Leading to Progressive Wire Failures then Cracked Concrete which leads to Corrosion and Failure of Steel Cylinder, Miscellaneous Manufacturing Defects.
- Pre-Stressed Wire Corrosion:
  - Electrochemical Corrosion: Common Corrosion due to Exposure to Ground Water or Potable Water. Occurs when the PCCP Concrete Mortar Coating is Damaged or Compromised.
  - Hydrogen Embrittlement: Brittle Tensional Failure of Wire due to Exposure to Hydrogen Unintentionally Introduced during Forming Operations and Increases Cracking in the Material. Some PCCP Wires were Subject to this During Pipe Manufacturing.

Common Types of Mortar Coating Damage: Third Party Damage, Handling, Improper Pipe Bedding or Trench Backfill Material, Etc.

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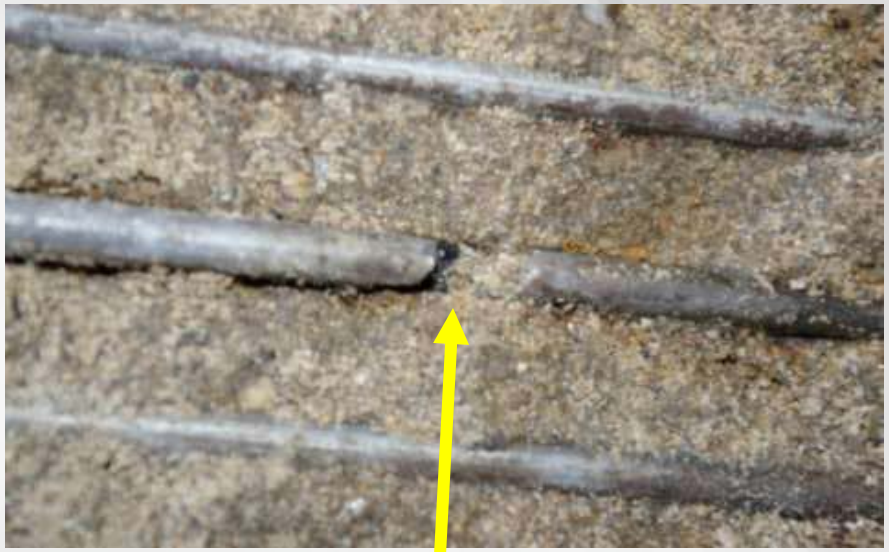
Pipe/Wire Corrosion

Hydrogen Embrittlement Wire Failures:

Wire Split Fractures



Wire Tensile Fracture

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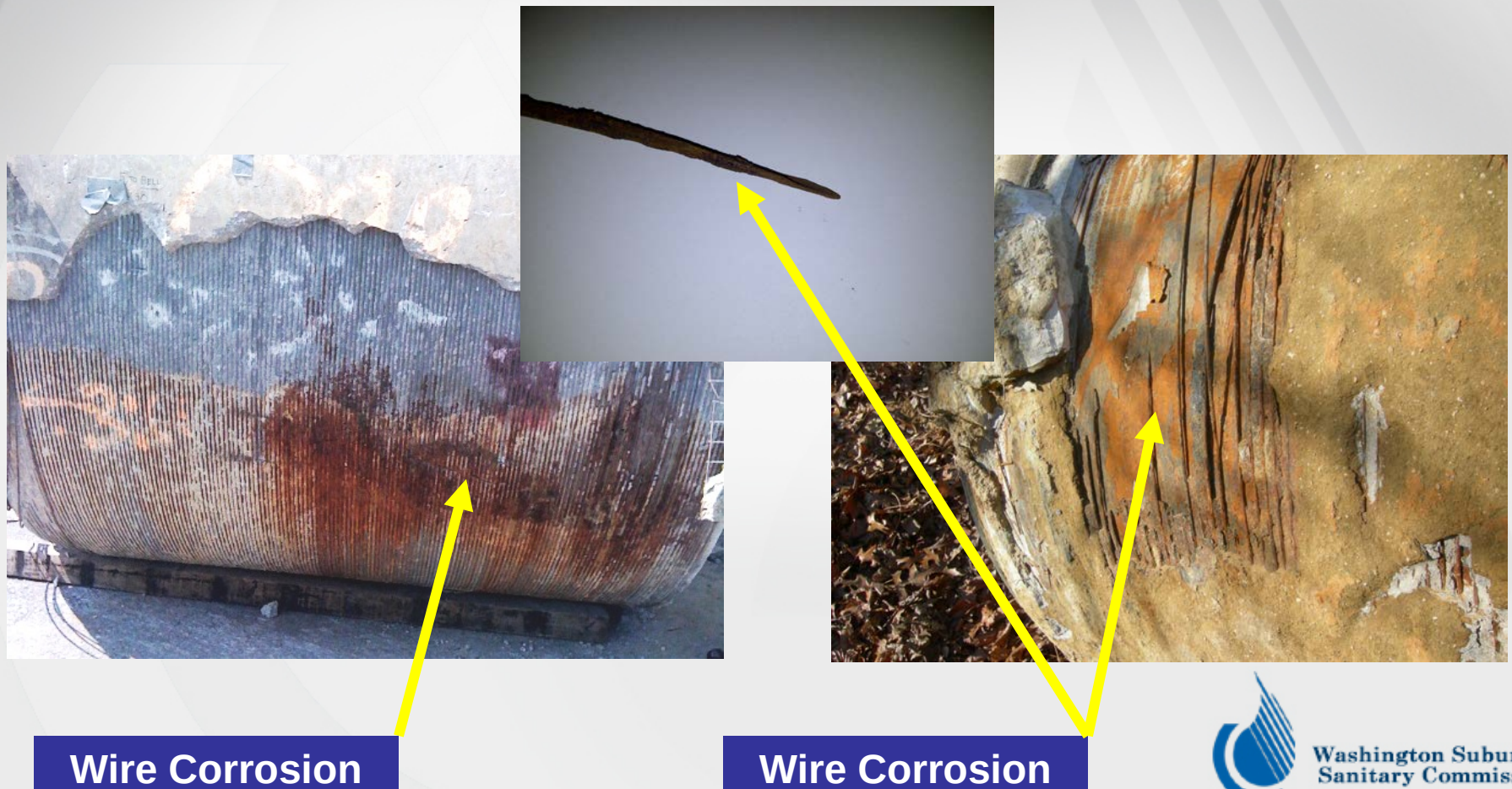
Pipe/Wire Corrosion

Wire Failures Due to Electrochemical Corrosion:



Wire Corrosion

Wire Corrosion

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Are PCCP Technologies 100% Guaranteed?

WSSC Uses State of the Art PCCP Technologies.

What They Cannot Guarantee:

- Electromagnetic Testing: Cannot Detect Broken Pre-Stressing Wire Within Approximately one foot of the edge of Steel End Rings and Steel Saddle Plates used for Factory Fabricated Outlets.
- Acoustical Leak Testing: Cannot Detect Very Small Leaks.
- Acoustical Fiber Optic Monitoring: Cannot Detect Wire Breaks on Pipe that is not Properly Pre-Stressed: Example: Chevy Chase Failure.
- AFO Monitoring is susceptible to power and communication outages.

Other Challenges;

- Shutdowns for Emergencies are Typically Manual and Take Time and Often Require Multiple Valve Closures.
- Conflicts with Other Operational Constraints may Complicate Emergency Shutdowns or Create Large Water Outages.

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Questions

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