



# Natural Gas Technologies 2005 Conference

## Development of a Remote External Repair Tool for Damaged or Defective Polyethylene (PE) Gas Pipe

Presented by  
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**Timberline Tool**

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# Introduction

- ▶ Since incorporating in 1989, Timberline has been developing innovative tools used by natural gas utility operators to maintain and repair PE pipe.
- ▶ In 1999, Timberline began developing tools specifically for repairing PE pipe in keyhole situations.
- ▶ Timberline tools are currently being used by natural gas utility operators worldwide.

1989

1992

1997

1999

2002

2003

2004



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## Remote External Repair Tool for 4-inch PE Gas Pipe

- ▶ External repair methods for PE pipe are being investigated at Timberline Tool and Oregon State University under a cooperative agreement with DOE/NETL.
- ▶ Current repair procedures require multiple excavations, isolation, and removal of the damaged section of pipe followed by fusing a new section of pipe into place.
- ▶ This project will develop a new methodology and tool for externally repairing damage or defects on PE pipe by applying a repair patch over the compromised area.
- ▶ This presentation reviews the initial design and development of the mechanical device and two chemical processes for repairing damaged PE pipe.



# Background

## Natural Gas Delivery System

- The use of PE pipe for natural gas transmission & distribution has been steadily growing in the U.S. and accounts for a majority of America's natural gas distribution network.
- The current delivery system consists of 650 thousand miles of underground PE piping in service for over 30 years.
- It is important to keep the delivery system safe, reliable and efficient.

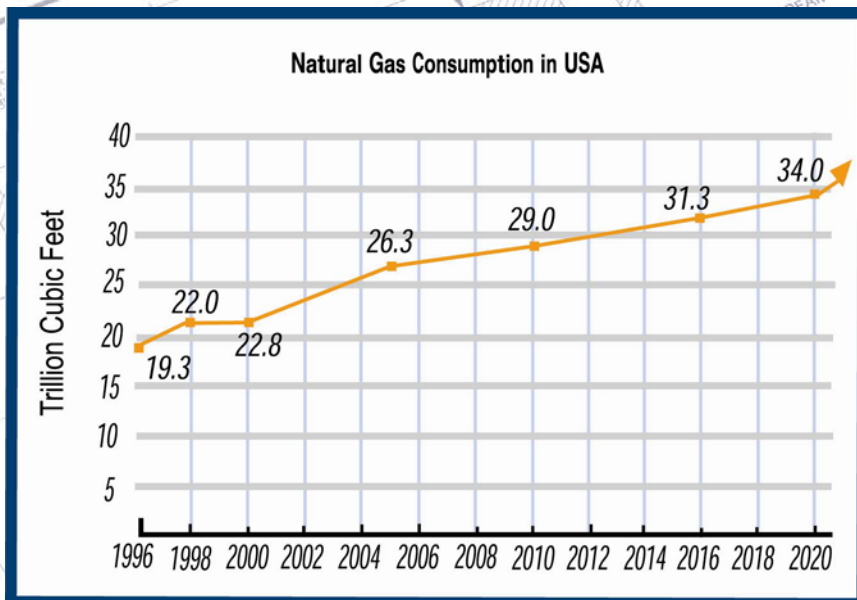
U.S. Natural Gas Pipelines

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# A Growing Need

## Maintaining a Growing Infrastructure

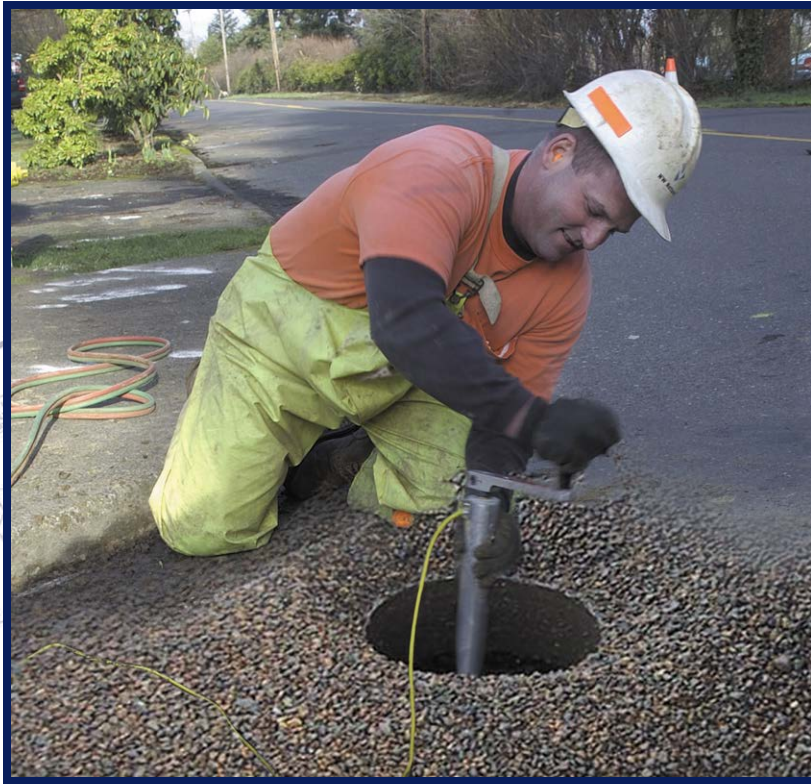
- ▶ The U.S. Department of Transportation forecasts a 50% increase in the demand for natural gas by 2020.



- ▶ Need improved tools for maintenance & repair of PE pipe to keep up with the expected growth
- ▶ This project responds directly to this need.
- ▶ Goal is to help maintain the safety, reliability, and integrity of the U.S. natural gas delivery system



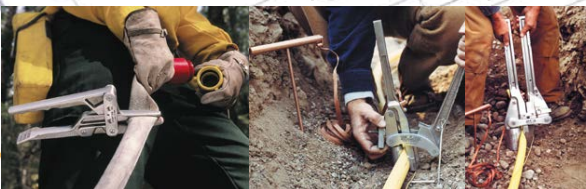
# Operating Procedures



- ▶ Natural gas operators are turning to keyhole technology for increased safety and cost savings.
- ▶ Since 1999, Timberline has been developing PE pipe repair tools for use in keyhole

1989 1992 1997 1999

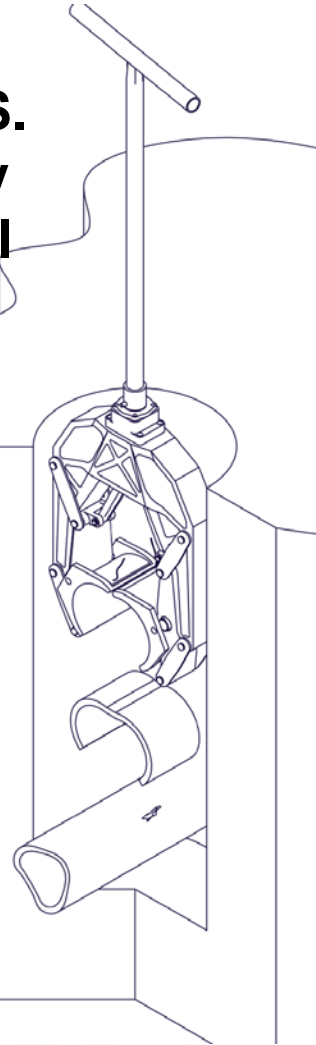
2004



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# Repair Tool Development

- ▶ In 2003, Timberline received an award from the U.S. Department of Energy National Energy Technology Laboratory to develop a remote external repair tool for PE Pipe.
- ▶ The focus of this research is to encapsulate the damaged area of the pipe and apply a chemical patch to permanently repair the pipe.
- ▶ This project will develop a new method for repairing damaged or defective 4-inch PE pipe.



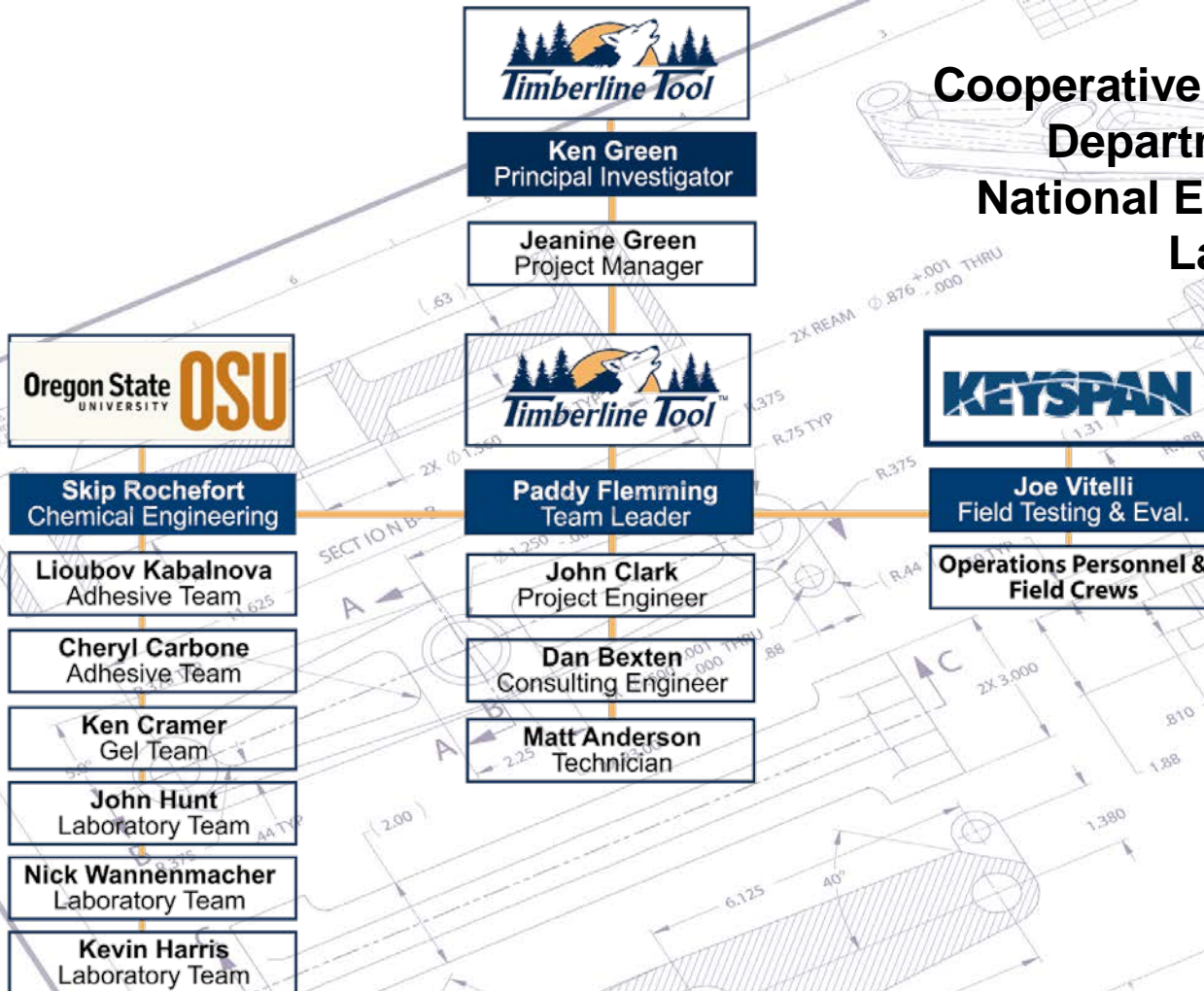
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# Repair Tool Team

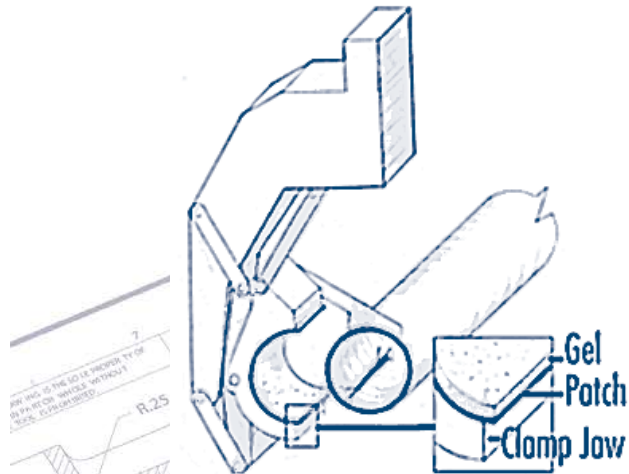
**Cooperative Agreement with the  
Department of Energy  
National Energy Technology  
Laboratory**



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# Repair Process

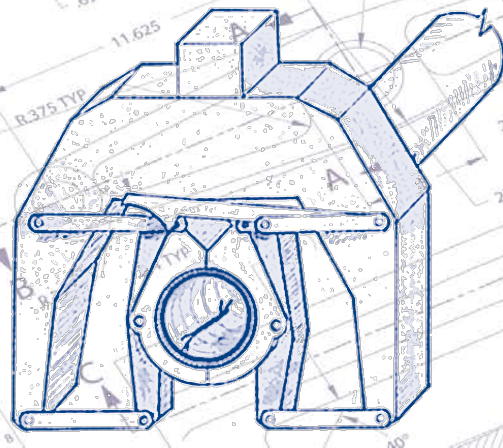


▶ **Curved jaw fits the contour of the pipe as it closes.**

▶ **Allows operator to fully enclose the damaged section of pipe with the repair patch.**

▶ **Stops the flow of gas through the damaged pipe wall.**

▶ **Permanently repairs the damaged area.**





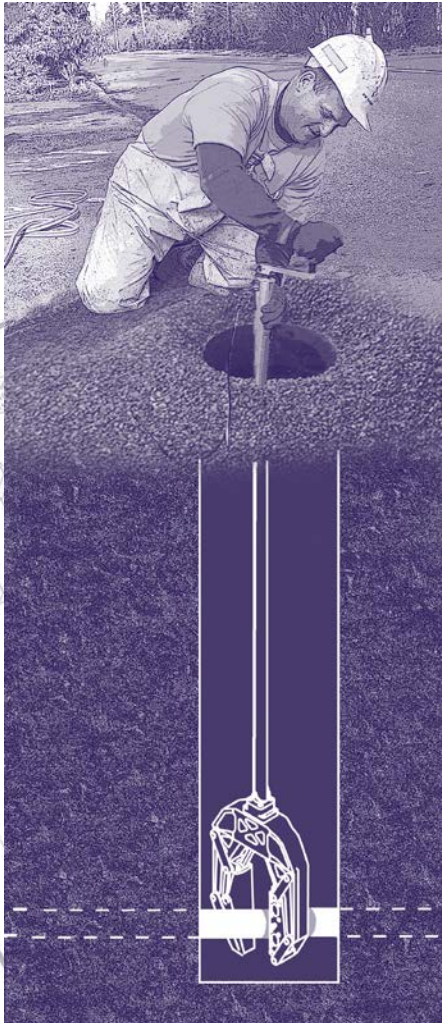
- ▶ **Current repair procedures for PE gas pipe require multiple excavations, isolation, and removal of the damaged section of pipe followed by fusing a new section into place.**



# Repair Tool Design

- ▶ **Lightweight & portable**, constructed of aluminum for mechanical operation by a single person.
- ▶ **Remote operation** keeps operator away from leaking gas
- ▶ **Top-down application** without the need to fasten the device under the pipe
- ▶ **Operable in keyhole situations** without the need for squeeze-off.
- ▶ **Curved jaw design** allows for encapsulation of the pipe.

# Safety Benefits



► Remote, top-down operation keeps operators out of the trench.

► Minimal excavation creates a safer working environment.

► Repairs are completed faster.

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# Cost Savings

► **Significant time & labor savings due to ease of application**

► **Significant savings by eliminating need for extensive excavation.**

► **Dramatically reduces costly pavement restoration.**

► **Increases productivity. Only one operator and one excavation required.**

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# Innovative Repair Tool Project

► PE pipe will be repaired externally.

► Repairs will be performed without shutting off the flow of gas.

► A mechanical tool will apply the repair patch over the damaged area.

► Patch will be chemically bonded.

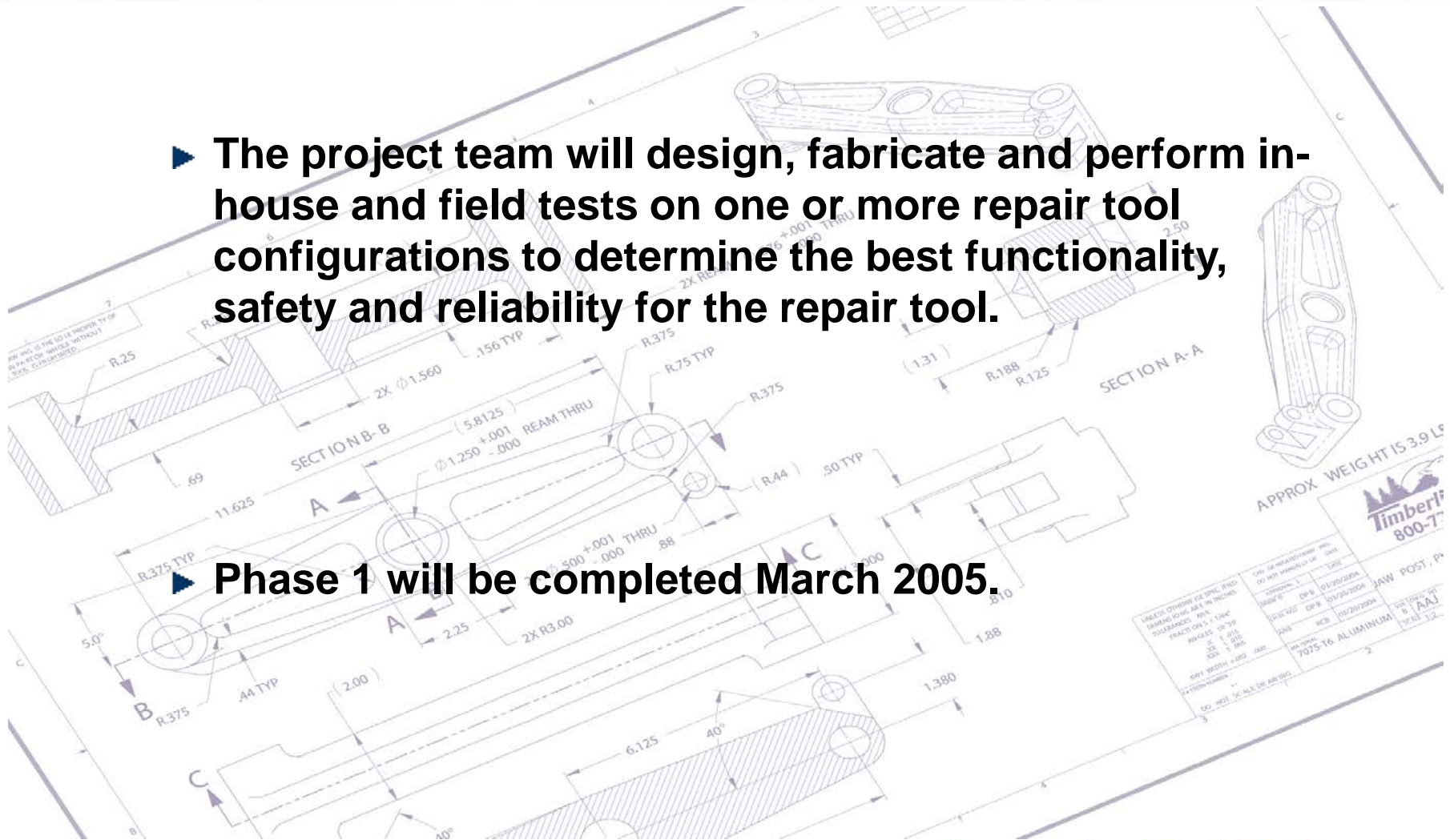
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# Phase 1

- ▶ The project team will design, fabricate and perform in-house and field tests on one or more repair tool configurations to determine the best functionality, safety and reliability for the repair tool.

- ▶ Phase 1 will be completed March 2005.



# Phase 2

- ▶ The project team will use information gained in Phase 1 to guide the construction of one or more engineered prototype repair tools. In-house and field tests will be performed on these engineered prototypes and laboratory tests will be performed on repaired 4-inch PE pipe sections.

- ▶ Phase 2 will be completed March 2006.



# Repair Concepts

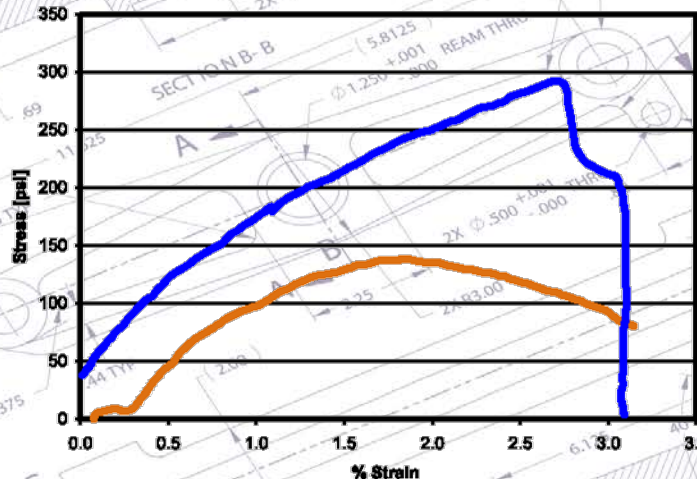
- **Concept 1: Polyethylene gel bonding uses a gel containing a bonding agent attached to a PE patch to join the surfaces of the PE patch material and the damaged PE pipe.**

- **Concept 2: Polyethylene adhesives utilize structural plastic glues to join the surfaces of the PE patch and the damaged PE pipe.**

# Repair Concept 1

- Polyethylene gel bonding uses a gel containing a bonding agent attached to a PE patch to join the surfaces of the PE patch material and the damaged PE pipe.

Compiled Gel Shear Tests

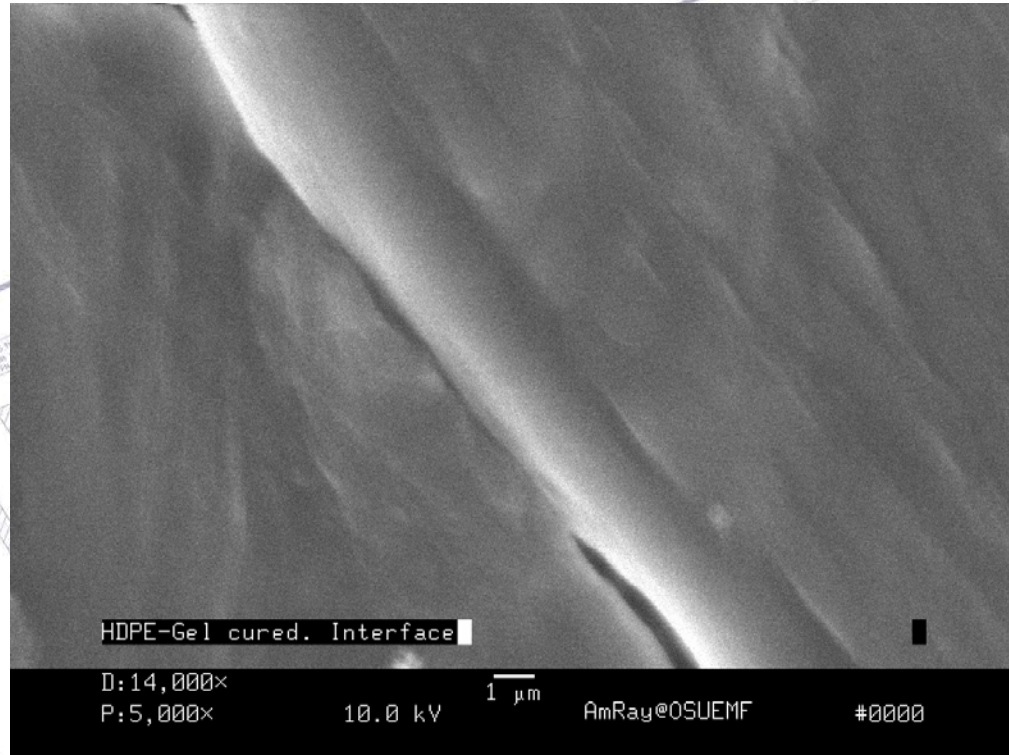


- Early shear test results show successful bonding of two HDPE samples.



# Repair Concept 1

- ▶ Gel creates a relatively seamless joint.
- ▶ An ideal bond joint would be difficult to differentiate from this sample

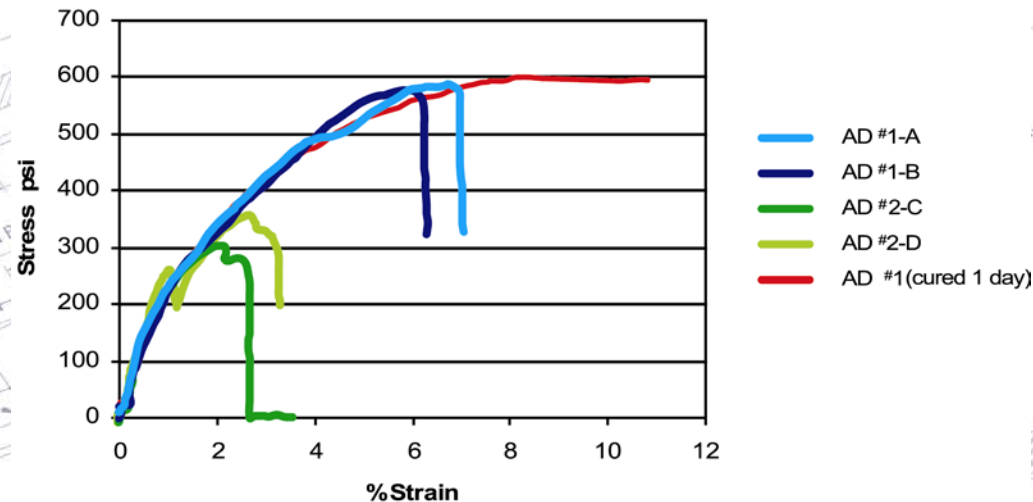


**SEM Bonded Cross Section**

# Repair Concept 2

- Polyethylene adhesives utilize structural plastic glues to join the surfaces of the PE patch and the damaged PE pipe.

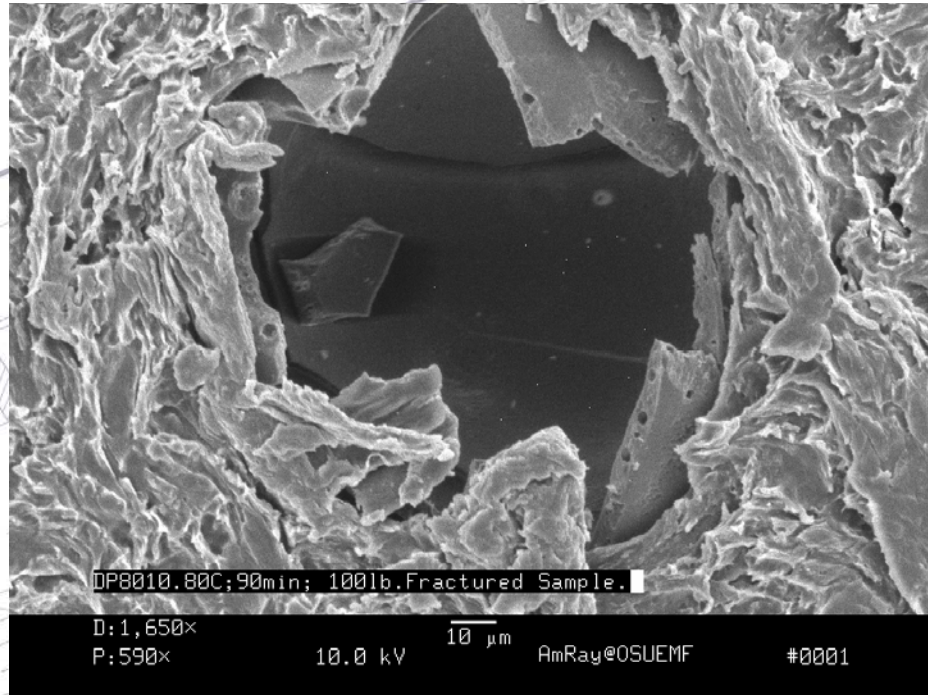
AD#1 & AD#2 Shear Tests (5/27/04)



- AD #1 and AD #2 cured at 80°C for 90 minutes in the Carver Press. One AD #1 sample cured at 80 °C for 24 hours in the Carver Press.



# Repair Concept 2



**Sample 1 cured at 80°C for 90 minutes in Carver Press with 50 lbs pressure. Glass sphere broken during shear test. 1650x magnification.**

# Project Completion

- ▶ The completion of the project will involve construction of an engineered prototype for 4-inch diameter MDPE & HDPE pipe.
- ▶ Laboratory and field tests will be performed on the prototype and repaired pipe samples under well-defined testing and operating procedures of natural gas distribution systems.
- ▶ The effectiveness of the design will be reviewed and modifications made in preparation for commercialization of the tool.





# Acknowledgements

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