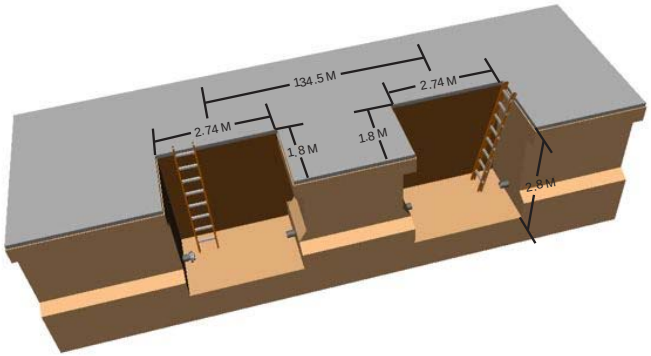
Rehab with Polyurea as SIPP Option

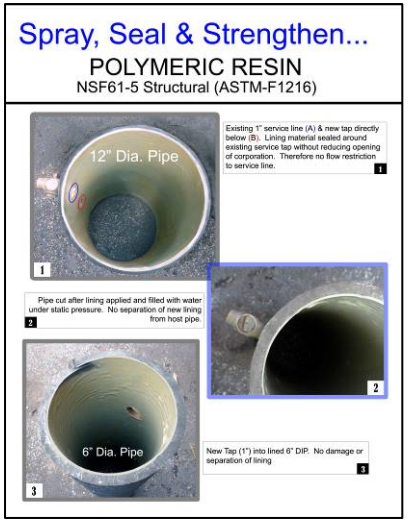


Traditional - Current Application Methodology

Future Deployment Capabilities

(SIPP) Spray-In-Place Pipe

Presenter - *James Baglier*



Pertinent Background:

1. Began developing elastomeric coatings in the early 90's
   - Encasement of asbestos, heavy metals, ect.

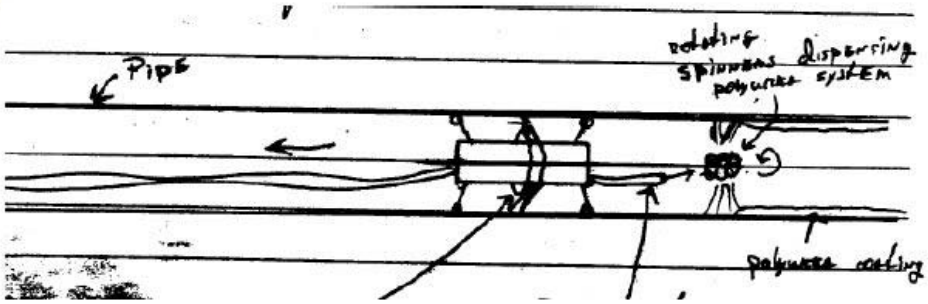
2. Performed first polyurea spray application in 1997

3. Began acquiring rehab capability for wastewater systems
   - Manholes, vessels, tanks
   - Plants – various industrial waterproofing
   - Containment , moisture repression
   - Environmental – Brownfields, Landfills

4. 2002 Progressed to developing a concept for Pressure Pipe
   - Worked with, and on various spray tool designs
   - Manufactured & distributed SIPP field rigs

(SIPP) "State of the Art" at conception - Polyurea Pipe Lining Concept:

- First disclosed in 1989
  - AL 8824 Patent Suggestion, Texaco Chemical Company



- Subsequent work in UK in mid 90's
  - Shot independent streams of ISO component and Resin component, mixed on "spinner"

(SIPP) “State of the Art” at conception - Polyurea Pipe Lining Concept:

Early Spray Gun (Video)

Advantages made SIPP Highly Anticipated:

- Polyurea is usually a 1:1 100% solids with no VOC material
- Material is dispensed with plural component spray equipment
- Short gel time & rapid cure allows quick return to service
- Can be formulated with specific desirable physical properties

Sample #2	
Pipe Size:	6" PVC Pipe – 10' long
Tip Size:	#8 Spraying Systems Tip
Nominal Flow Rate:	1.1 gallons/minute
Pull Speed:	21 feet/minute
Estimated coating per pass:	.050"
Number of passes:	4
Measured minimum coating thickness:	.165"
Measured average coating thickness:	.240"
Length of 6" diameter pipe tested:	12"
Cure time before test:	30 days
Nominal burst pressure when tested:	200 psi

Typical Burst Test Results

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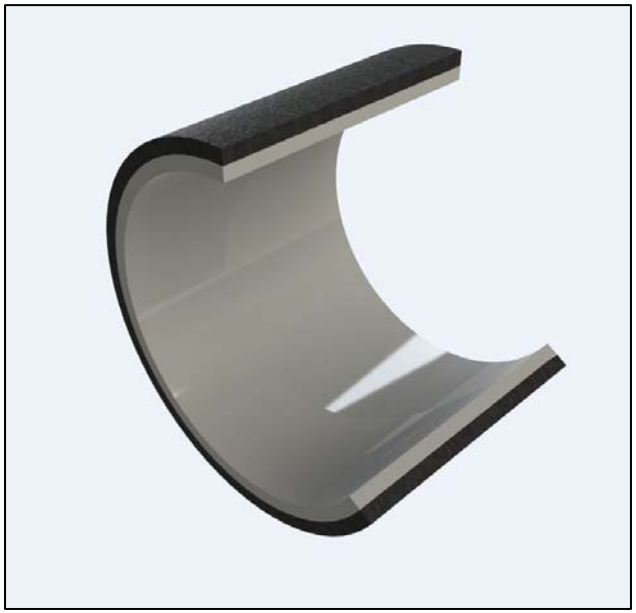

Drill-Tap New Service (Video)

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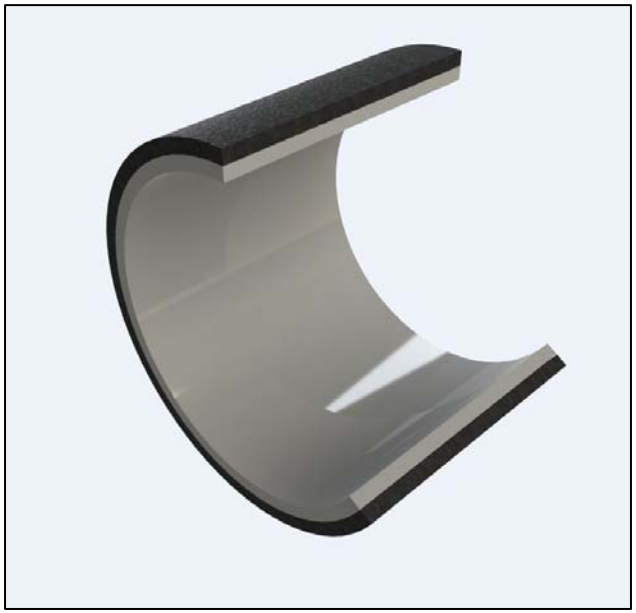
- Material is dispensed with plural component spray equipment
- Short gel time & rapid cure allows quick return to service
- Can be formulated with specific desirable physical properties
- Forms to the host pipe with no annular space
- Accommodates various pipe diameters
- Lateral tie-ins remain clear following application

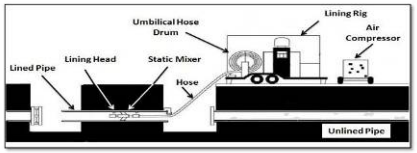


An ideal solution for:

- Potable Water Mains
- Force Mains
- Transfer Lines
- Myriad of Industrial & Commercial Applications

However, SIPP Lining Has Evolved Little & Grown Slowly:

- Typical installation diagram — Circa 1996
  - Surface preparation is similar setup
  - CCTV's observe real-time installation
  - Automatic hose real controls speed / application film build



Deployment & Technical Issues, Lack of IP - Investment:

- Thorough cleaning of the host pipe is paramount for success
- Suitable temperature, dew point, and air flow is required

Cleaning (Video)

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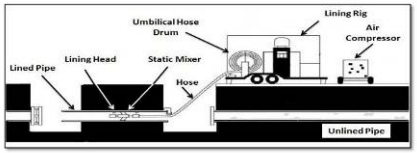

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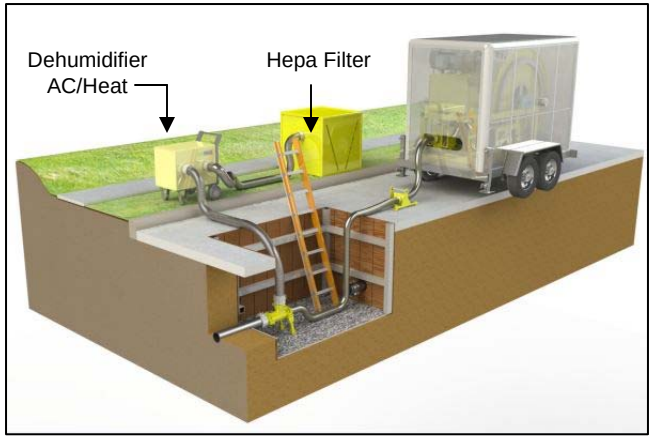

Slides-Right

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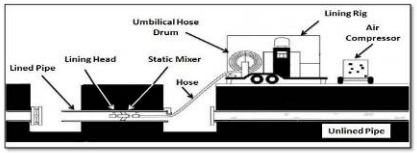

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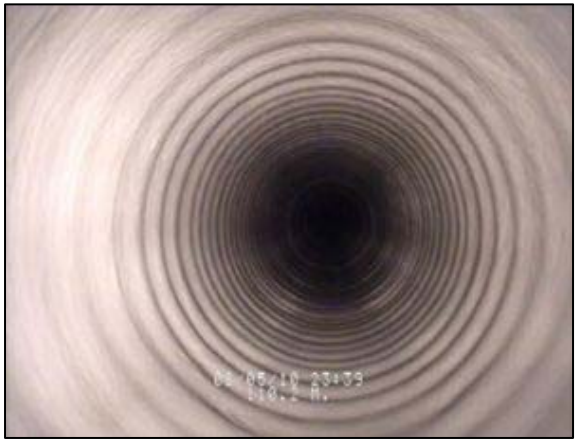
Slides-Right



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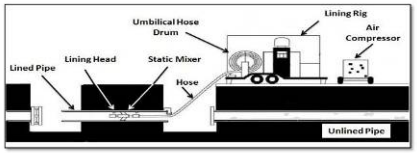

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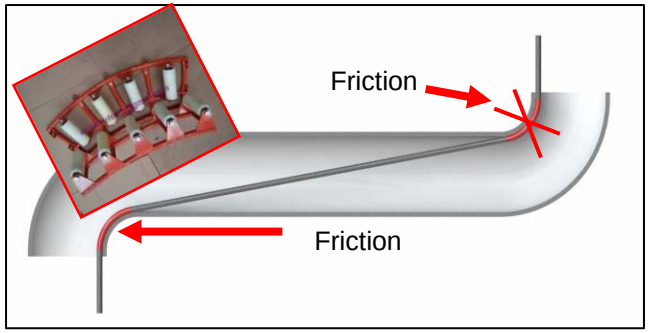
- Supply lines create friction limiting navigation of elbow fittings
- Only straight pipes are commonly lined



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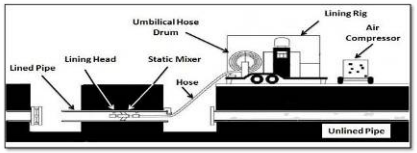

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- Supply lines create friction limiting navigation of elbow fittings
- Only straight pipes are commonly lined
- **Deployment constraints have limited accelerated growth**

SIPP Lining - Large Pipe

- First Commercial Use – 1995
  - Southern Underground
  - Waste water pipeline
    - Houston, Texas
  - Not a 360° coverage / bottom bare
  - Large diameter / ride-on unit

Video

ICI Polyurethanes Review, Vol 6, No 8, October 1996

SIPP Lining - Large Pipe

Robotic Spray-In 2015:

- Ohio Department of Transportation

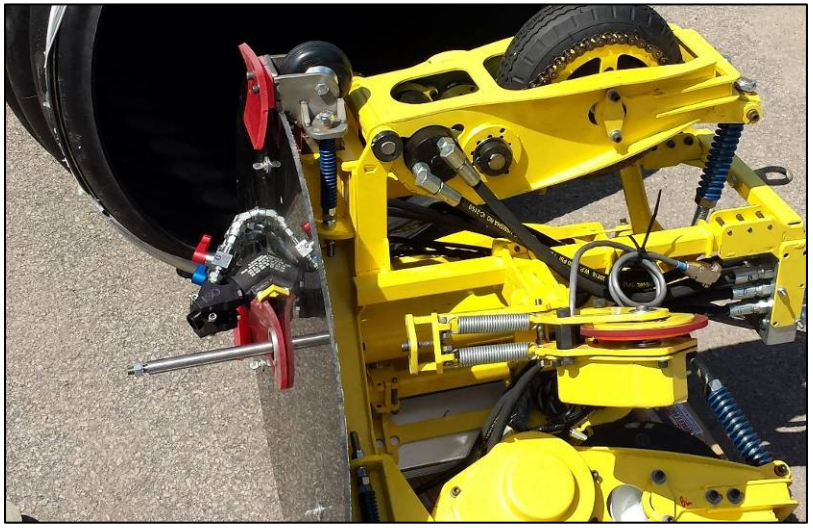
-72” Storm Concrete Storm Drain
Cleveland Ohio

- Self Deployed 360º Coverage Structural Liner (750 m)

Video

SIPP Lining Techniques & Tools Are Evolving

First Spin Applicator 1992



Spin Applicator 2012

A History of Materials and Robotic Application

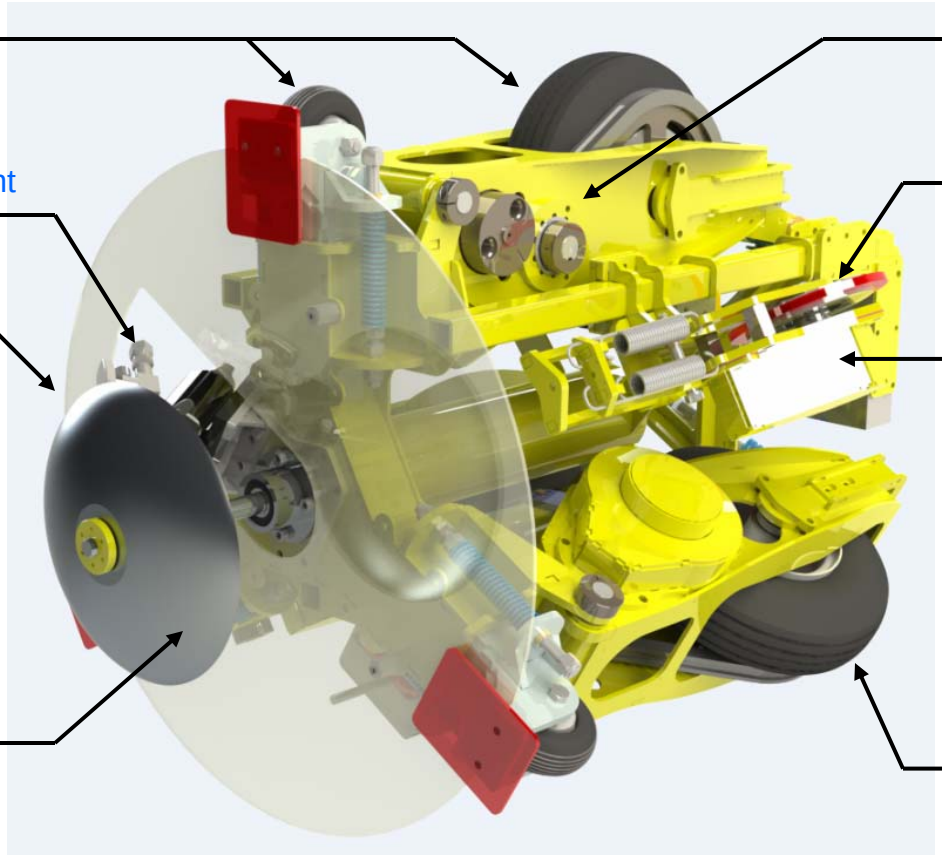
SIPP Lining Techniques & Tools Are Evolving

Self Centering Dual Independent Three Point Contact Wheel Sets

Self Purging Dual Component Spray Actuators (Heated)

Spray Shield and Air Flow Deflector

High Speed Bi-Directional Spin Cast Spindles



Hydraulic Displacement Drives x3

Encoder Feedback For Precise Speed Control & Position

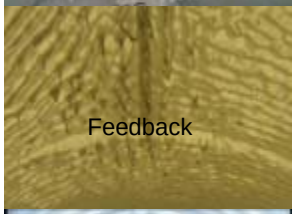
Sensor Array

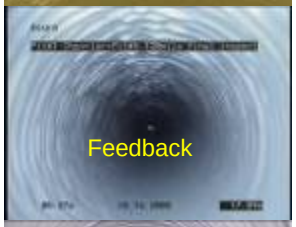
- Ambient Conditions
- Poly Temperature
- Poly Pressure
- Spindle RPM Direction
- Linear Speed
- Direction & Position
- All Switch States

Positive Grip Pneumatic Drive Tires

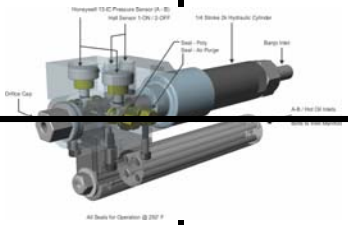
Optimal Design for Transitioning 90º Ells

On Board Sensor / Performance





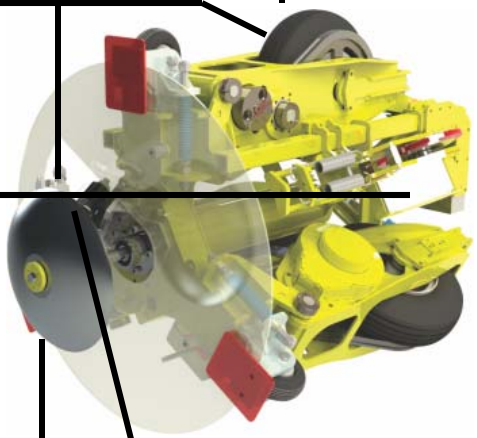
On/Off Hall Sensor



Gel Time
Traverse Speed
Mismatch

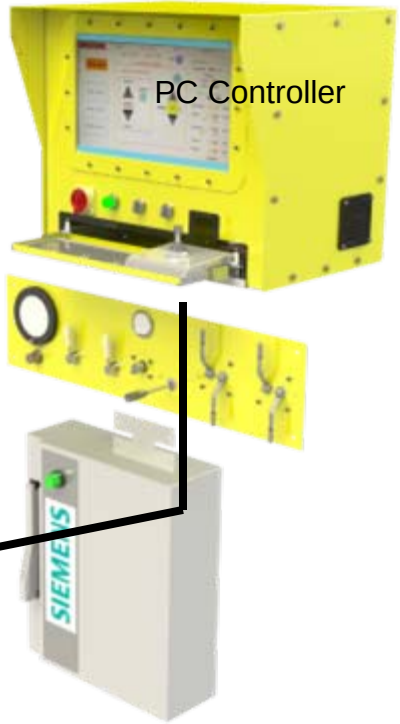
Ringing Caused by
Poor Speed Control
During Retraction

Blistering Indicates
Excessive Moisture
Due Point / Temp

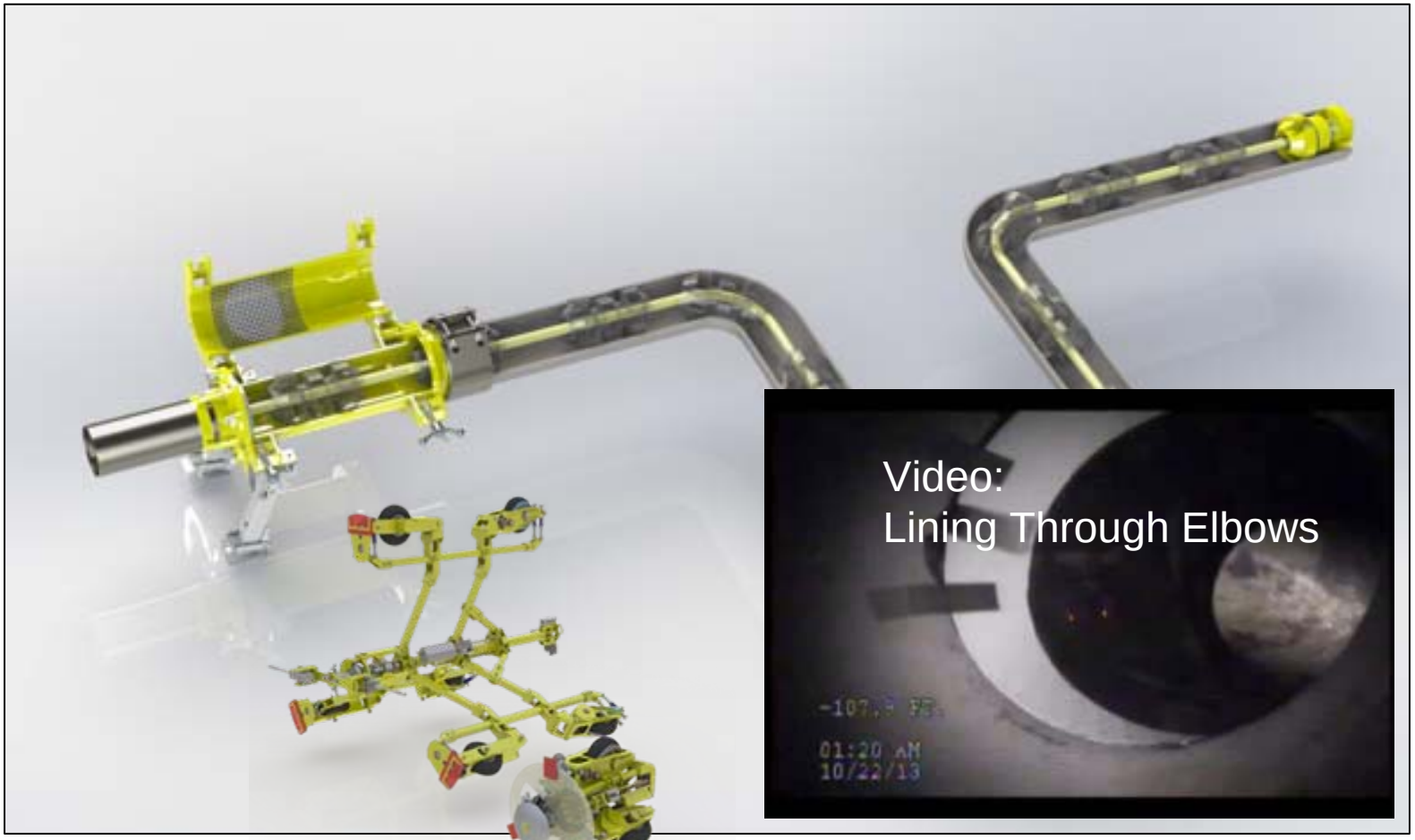


Shadowing Can Result From
Improper Disk RPM
Failure to Reverse Rotation
Improper Resin Blending
Excessive Travel Speed

Holidays and Thin Coatings
Result From Poor Resin/ISO
Blending. Pressure Sensors
On Resin and ISO Circuits
Negate Mixture Errors.

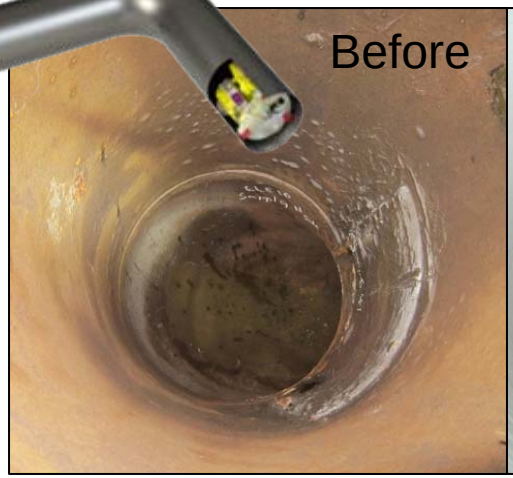


SIPP Lining - Complicated Pipe Geometries

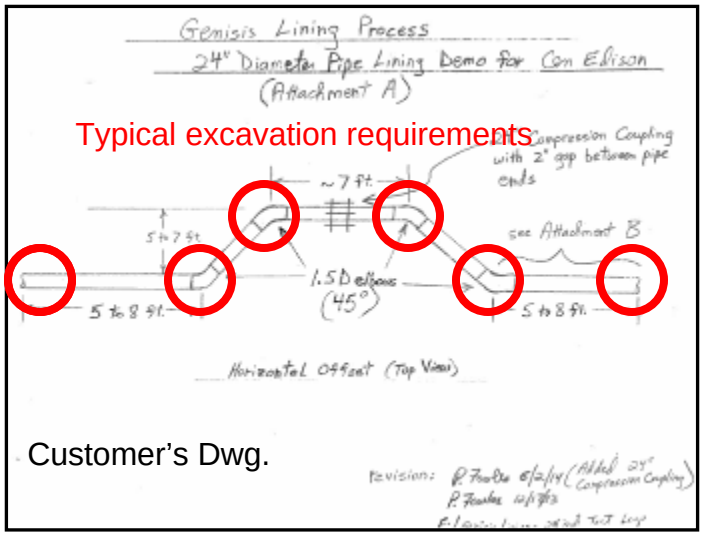


- 6 Inch Through Unlimited Pipe Sizes

Exxon Mobil Rehab (Singapore)



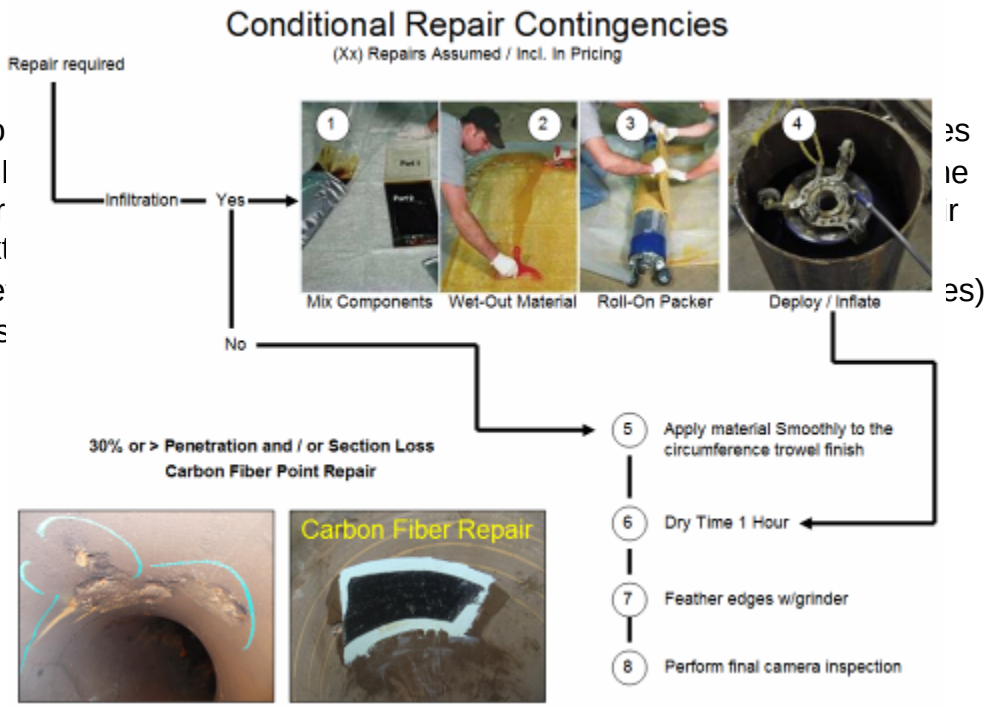
Con Ed Mock-up March 2015



Customer's Dwg.

To Perform A Successful SIPP Project

1. Establish Host Pipe Condition – Viability to Meet Customer Goals
   A. Substrate material determines applicable cleaning & potential repair methods
   B. Pipe size determines what tools and techniques will be possible
   C. Anticipate potential roadblocks & have contingency procedures identified



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   E. Test unproven anticipated procedures and equipment prior to mobilization

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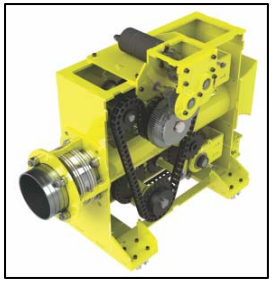
   - D. Agree up-front on mitigation procedures, implementation triggers, & pricing
   - E. Test unproven anticipated procedures and equipment prior to mobilization
2. Surface preparation is paramount to Success
   - A. Substrate material and pipe usage determines viable cleaning methods
   - B. Cleaning process must fit the circumstances i.e. (water in gas lines “big no no”)
   - C. How will undesirable pipe wall contaminants and chemical impurities be negated
   - D. Develop containment & debris removal procedures early in the planning stage
   - E. Have anticipated procedures pre-approved by resident or consulting engineers
3. Environmental & Ambient Conditions **Must** be Controlled
   - A. Internal pipe wall must be dry
   - B. Temperature and resulting dew point must be maintained throughout the lining process
   - C. Air flow (temp & speed) must be maintained at the tool throughout the length of the pipe
4. Proper Material Selection & QAQC Sign-Off Requirements
   - A. Pipe – wall condition, operating pressure, and material conveyed determine selection
   - B. Pipe size determines the application thickness per specified service duty
   - C. Testing procedures and installation validation should be agreed on in the award phase
   - D. Implementation of unproven formulations or application methods should be validated
   - E. 3rd party testing and validation

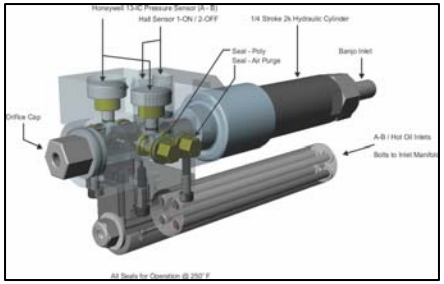
Control Architecture

Tether Drive Capability



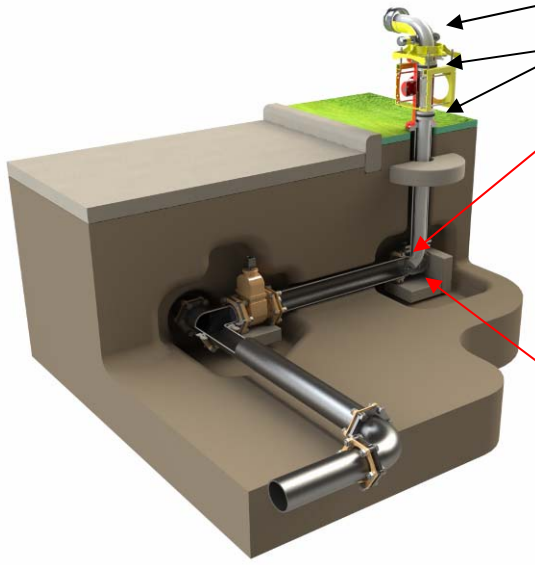
Hydrant Cleaning

Inspection / Lining



SIPP / In The Future

Existing Access Capability

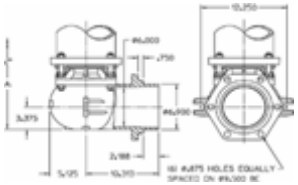


Launch Tube Insert

Insert Stabilizers & Centering Packers

Alignment & Clearance at Pipe Entrance

Exit Angle to Pipe Transition w/ Applicable Min. Bend Radius



NO DIG

1. *Cleaning*
2. *Inspection*
3. *Lining*

Potable Water

END