75-year History of Turning Raw Technology into Practical Energy Solutions

FOR A BETTER ECONOMY AND A BETTER ENVIRONMENT

SUPPLY  ➤  CONVERSION  ➤  DELIVERY  ➤  UTILIZATION

World-class piloting facilities headquartered in Chicago area
GTI’s Energy Delivery R&D Program Summary

- GTI has an expanding R&D portfolio focused on industry priorities:
  - Safety, Integrity, Reliability, Operational Efficiency, and the Environment
- Work closely with gas industry customers, Federal and State government agencies, and industry suppliers to:
  - Bring exciting new technologies and products into development
  - Push for implementation of results
- Collaborative R&D efforts:
  - Highly cost effective
  - Leverages collective intelligence and experience of funders to develop the best possible solutions
Operations Technology Development (OTD)

Mission

• Identify, select, fund, and oversee research projects resulting in innovative solutions and the improved safety, reliability, and operational efficiency of natural gas systems

Goals

• Enhance safety
• Enable operational excellence
• Minimize environmental impact
• Provide good science

OTD Working Groups

- Smart Utilities
- Risk & Integrity Management and Environmental Matters
- Infrastructure and Gas Operations
OTD Members
Serving 50 million gas consumers in the US and Canada

<table>
<thead>
<tr>
<th>27 member organizations</th>
<th>Ameren Focused Energy. For life.</th>
<th>CenterPoint. Energy</th>
<th>Atmos Energy</th>
<th>Southwest Gas</th>
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<td>conEdison</td>
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Unprotected Steel Mains in Natural Gas Distribution

- Natural gas distribution operators are focusing on addressing issues with cast iron, unprotected steel and other aged piping infrastructure.
- Approaches currently in use to deal with the problem:
  - Replace with PE or new coated steel pipe materials
  - Apply cathodic protection to try and maintain integrity
  - Rehabilitation methods
    - Cured-In-Place pipe liners (Starline) and other in-situ methods
    - Localized repairs (external and internal)
    - Bursting / slitting pipes and pull in PE pipe
- Replacement – accelerated replacement programs
  - Barrier to replacement of all unprotected and other aged piping systems:
    - Main replacement can be very costly – cost per mile to replace from $1 to $5 million or more.
Gas Distribution Steel Miles – Bare and Unprotected

Steel pipelines with neither an external coating nor cathodic protection have a higher corrosion risk than coated and protected steel.

Bare Steel pipelines are 5% of the gas distribution pipeline systems currently in service.

Unprotected Steel pipelines are 7% of the gas distribution pipeline systems currently in service.

Unprotected Coated Steel pipelines make up 3% of the gas distribution pipeline systems currently in service.

Data Source: US DOT Pipeline and Hazardous Materials Safety Administration
Data as of 10/6/2019

Service counts are converted to miles using the operator’s average service length or 90 feet if the operator has not submitted an average.
Bare Steel Mains in Natural Gas Distribution

- Operators (top 11) list by total miles of bare steel main in service →
  - Over 44,000 miles remain in US
  - Over 1.8 million services

<table>
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<tr>
<th>Operator Name</th>
<th>Main Miles</th>
<th>Change</th>
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<td>DOMINION ENERGY OHIO</td>
<td>3,512</td>
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<td>SOUTHERN CALIFORNIA GAS CO</td>
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<td>MOUNTAINEER GAS CO</td>
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<td>NATIONAL FUEL GAS DISTRIBUTION CORP - NEW YORK</td>
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<td>COLUMBIA GAS OF OHIO INC</td>
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<td>KEYSPAN ENERGY DELIVERY - LONG ISLAND</td>
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<td>2,133</td>
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<tr>
<td>KANSAS GAS SERVICE COMPANY, A DIVISION OF ONE GAS, INC.</td>
<td>2,611</td>
<td>2,124</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30,082</td>
<td>24,069</td>
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Data Source: US DOT Pipeline and Hazardous Materials Safety Administration Portal – Data as of 10/6/2019
GTI Projects Related to Developing & Evaluating Pipe Repair / Rehabilitation Technologies

- Developing and testing cured in place liner technologies (Starline)
  - Low and high pressure applications
  - Development of performance standards
- Evaluating various Structural Liners
  - Engineering assessment of composite and structural liners
  - Line permeation and dis-bondment evaluations
- Testing & analysis of composites for external repairs
- Design of composite repair systems
- Testing & development of spray-on repairs
- Composite Pipe Workshop & Roadmap.
Operators Efforts to Replace/Repair Aging Infrastructure

- Operators working with their State Commissions to implement accelerated main / service replacement programs
- Focusing on risk based pipe replacement / repair of aging infrastructure
- Identifying and deploying state-of-the-art technology that is fit for purpose to help replace / repair aging infrastructure
- Focus of replacement / repair is for unprotected steel, cast iron (especially smaller diameter), and vintage plastic piping systems to increase safety and reduce methane emissions.
Operational Issues & Performance Requirements

- Rehabilitated pipe needs to be considered “new asset” for rate recovery treatment
- Target life > 50 years
- Proven & demonstrated performance ≥ PE pipe
- Qualify for removal from PHMSA / State bare steel list
- Desire to avoid service interruption during rehab
- Need to maintain integrity of host pipe?
- Continue to monitor rehabilitated pipe through leak surveys and in integrity management programs
Summary

• Operators need various technologies that are fit for purpose to help replace / repair aging infrastructure
  – Cast iron
  – Unprotected steel
  – Vintage plastic
• Technology should have proven & demonstrated performance
• Operators need re-conditioned pipe classification
  – Remove from “leak prone” pipe lists
  – Can monitor and maintain as a replaced piping system
Tackling Important Energy Challenges and Creating Value for Customers in the Global Marketplace

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