



U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration

Pipeline Safety Research, Development and Technology



Natural Gas Infrastructure R&D and Methane Emissions Mitigation Workshop

Nov 2014



Thank You!

- We appreciate the opportunity to share!
- Much to share about DOT natural gas infrastructure R&D
- Many facets to the fugitive methane issue
- DOT/DOE – We would like to restart the practice of interagency coordination, collaboration and co-funding



Who Is PHMSA?

- We're one of nine agencies within DOT
- We develop and enforce regulations for the safe, reliable and environmentally sound operation of:

Approximately

- 2.6 M pipeline miles
- 2,600 pipeline operators
- 1M daily hazmat shipments
 - By land, sea and air



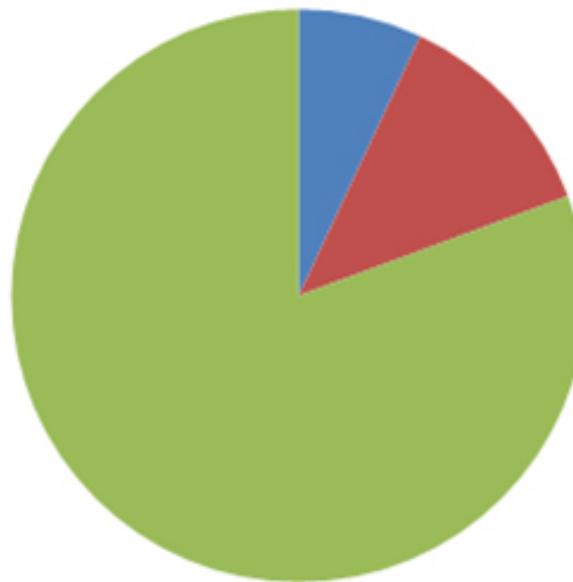


What We Regulate

National Pipeline System Components

Pipeline	Mileage	% Total	Operators	% Total
Hazardous Liquid	182,166	7	350	13
Gas Transmission and Gathering	324,832	12	1,034	39
Gas Distribution	2,113,643	81	1,285	48
<i>Main line</i>	1,232,266	47		
<i>Service line</i>	881,378	34		
Total	2,620,642	100	2,669	100

US Pipeline Mileage
2,620,642



■ Hazardous Liquid

■ Gas Transmission and
Gathering

■ Gas Distribution

Data as of 09/2012

U.S. Pipeline Transportation System

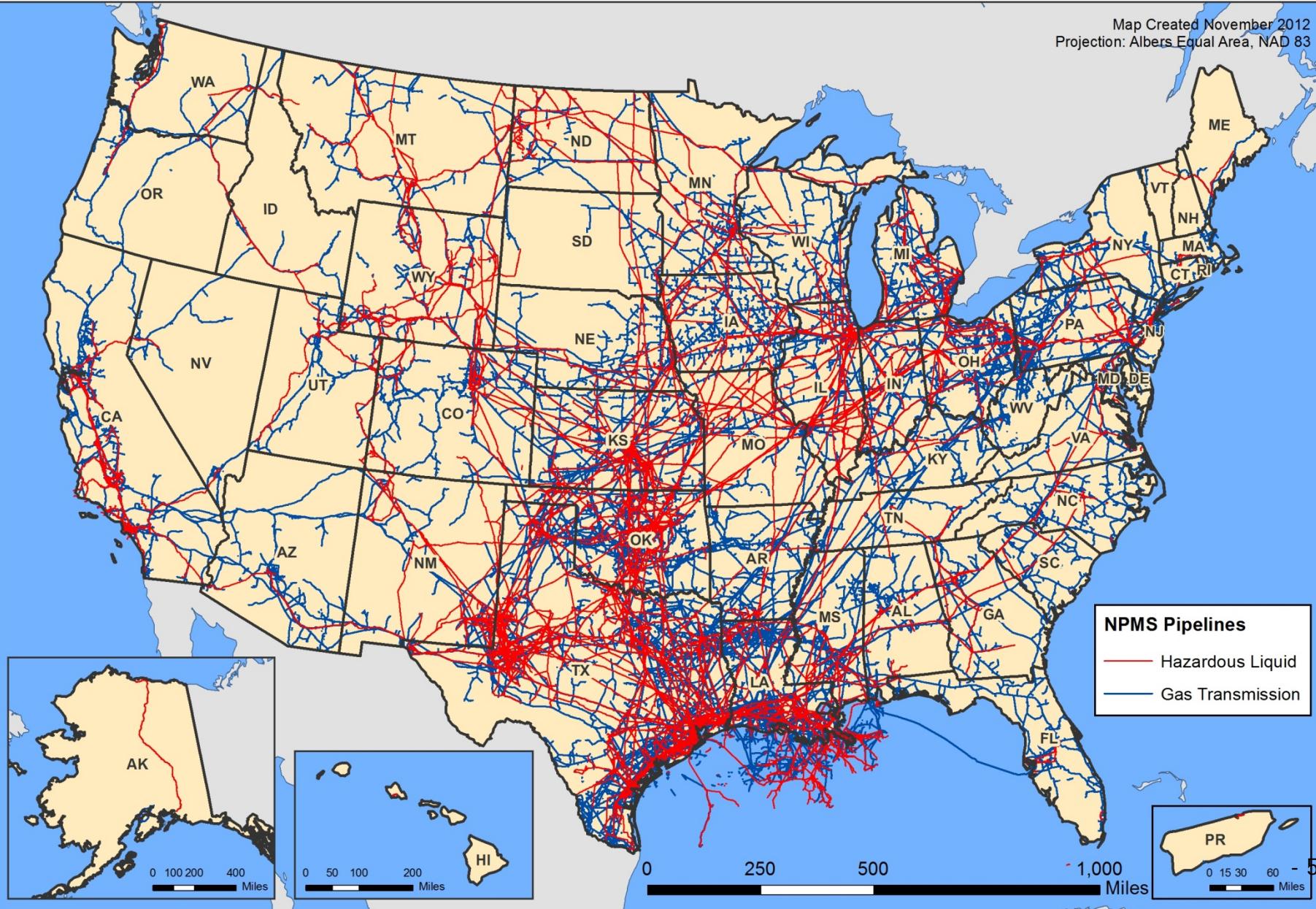
U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration

Gas Transmission And Hazardous Liquid Pipelines

Pipeline data as of 11/13/2012



Map Created November 2012
Projection: Albers Equal Area, NAD 83





Pipeline Safety RD&T

Pipeline Safety RD&T Program Mission:

To sponsor research and development projects focused on providing near-term solutions that will improve the **safety**, reduce **environmental** impact, and enhance the **reliability** of the Nation's pipeline transportation system.

Key Points

- We employ a collaborative approach to address mutual challenges
- We help remove technical barriers on a given challenge
- We measure our research results/impacts
- We are transparent - <http://primis.phmsa.dot.gov/rd/>

Pipeline Safety Improvement Act of 2002 established our modern program



RD&T Program Objectives

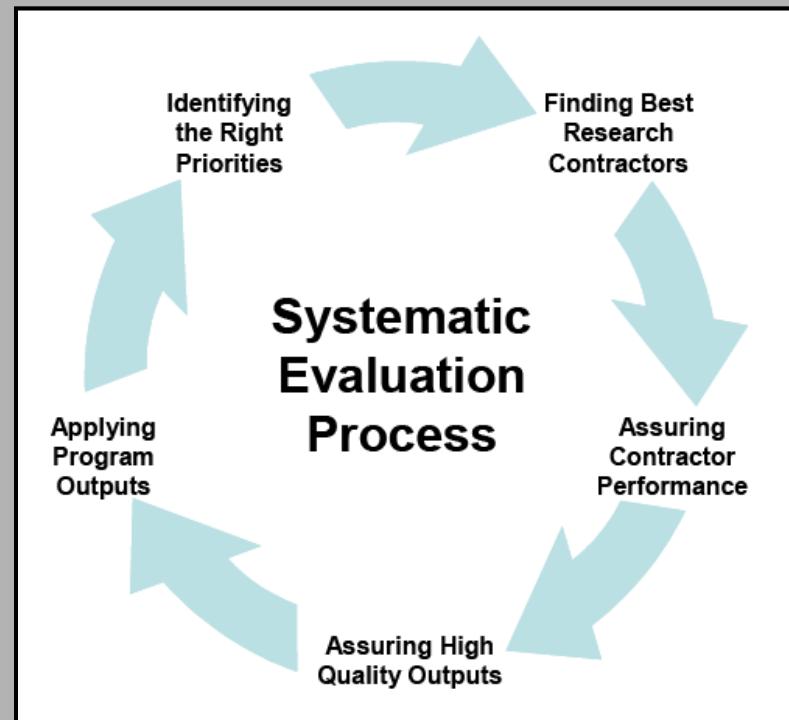
Developing Technology	Strengthening Consensus Standards	Promoting Knowledge
Fostering the development of new technologies so that pipeline operators can improve safety performance and more effectively address regulatory requirements.	Targeting and feeding new knowledge into the process of keeping standards relevant to their purpose.	Generating and promoting general knowledge to decision makers.

Authorizations vs. Appropriations

FY	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Authorization:	\$10M	\$10M	\$10M	\$10M	\$11.7M	\$11.7M	\$11.7M	\$11.7M	\$11.7M	\$6.92M	\$6.92M	\$6.92M	\$6.92M	\$6.92M
Appropriation:	\$4.8M	\$7.5M	\$7.8M	\$7.7M	\$7.7M	\$7.8M	\$6.9M	\$5.8M	\$6.9M	\$6.9M	\$6.9M	\$6.92M	\$12.2M	CR

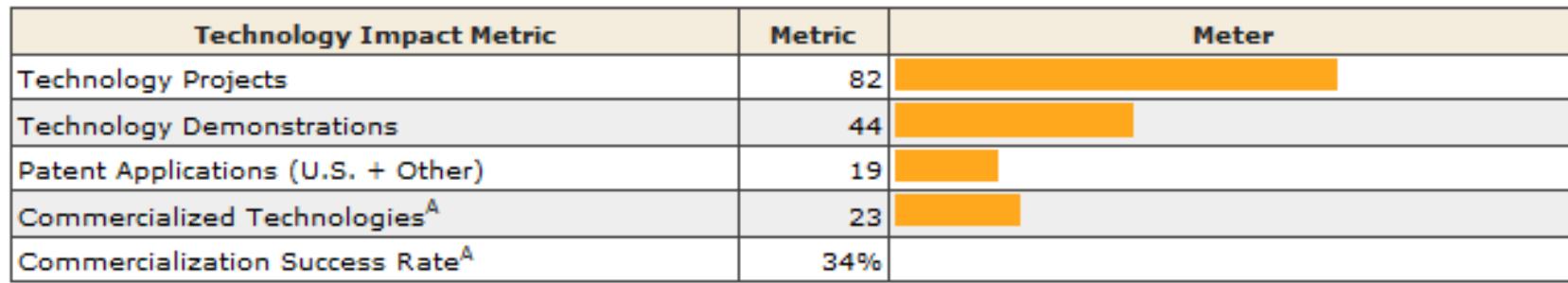
Collaborative and Coordinated Program Process

1. Stakeholder based, consensus driven research agendas and roadmaps
2. Interagency review of competitive pre-award process to reduce duplication, leverage resources and secure best researchers
3. Paperless & secure 21st Century solution used to monitor, report and assure contract performance
4. Post-award peer review process executed annually
5. Tech demonstrations and full use of contract authority to commercialize, disseminate and promote results



Performance Metrics (since 2002)

Program Status: Technology Impacts



Programmatic Element & Technology Research Impact

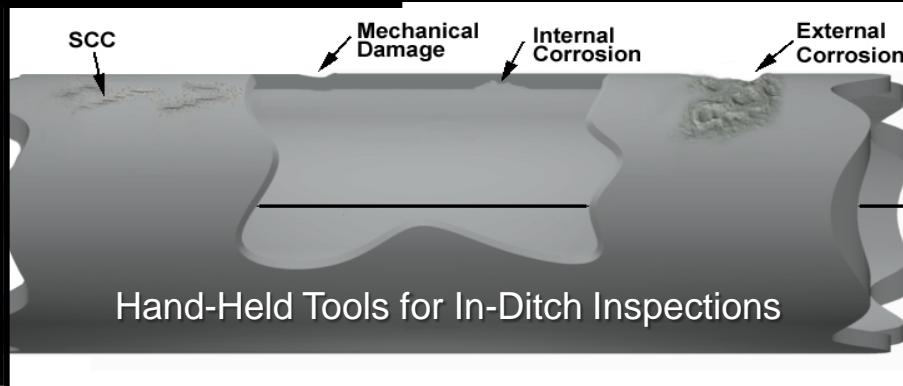
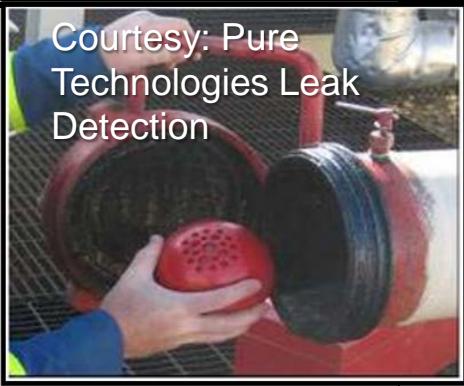
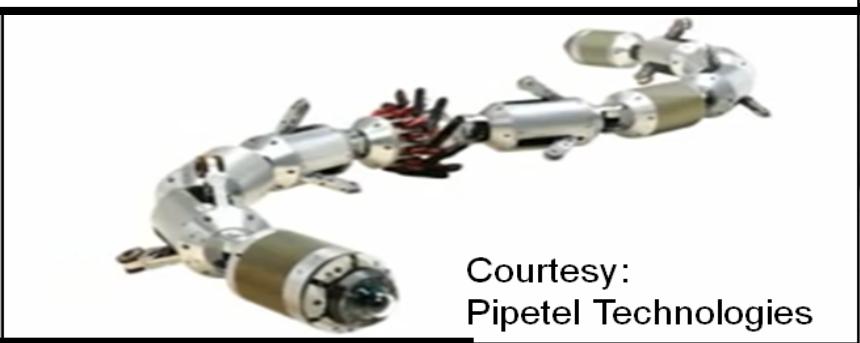
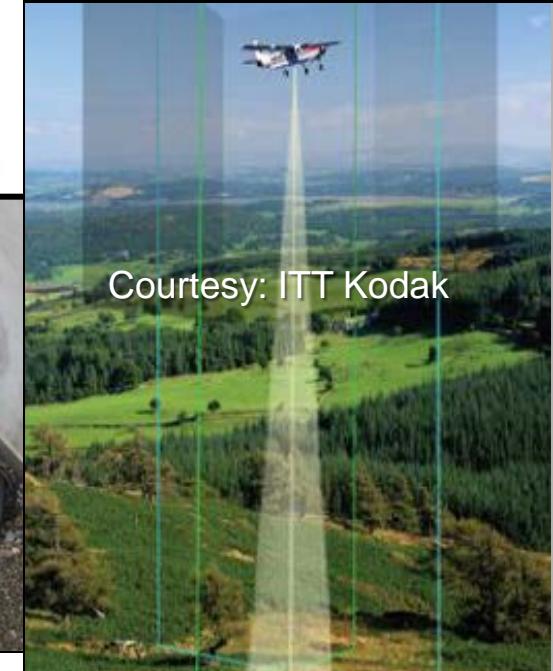
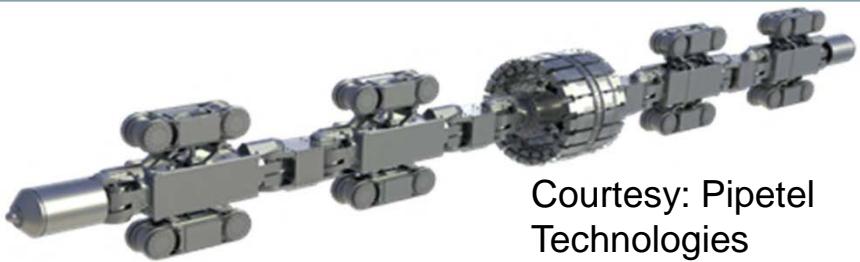
Category	Technology Projects	Technology Demonstrations	Patent Applications (U.S. + Other)	Commercialized Technologies ^A	PHMSA (\$M)
Threat Prevention	13	7	3	3	\$ 4.39M
Leak Detection	10	4	1	3	\$ 6.34M
Anomaly Detection	33	21	11	12	\$20.81M
Anomaly Characterization	9	3		1	\$ 4.32M
Design	1				\$ 1.71M
Materials	2		2		\$ 0.99M
Welding	7	5		2	\$ 4.92M
Joining	3	2	1		\$ 1.35M
Alternative Fuels	4	2	1	2	\$ 1.17M

Footnotes:

- A. Note: The measurement of "Commercialized Technologies" only occurs on non-active or completed projects.

Grand Totals:	82	44	19	23	\$46.04M
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PHMSA RD&T SUCCESSES





Performance Metrics (since 2002)

Program Status: Promoting Knowledge

Knowledge Promotion Metric	Count	Meter
Final Reports Publicly Available	163	<div style="width: 100%;"><div style="width: 100%;"> </div></div>
Conference or Journal Papers	102	<div style="width: 100%;"><div style="width: 100%;"> </div></div>
Public Events	36	<div style="width: 100%;"><div style="width: 100%;"> </div></div>
Patent Applications (U.S. + Other)	20	<div style="width: 100%;"><div style="width: 100%;"> </div></div>
Annual Peer Reviews Held	9	<div style="width: 100%;"><div style="width: 100%;"> </div></div>

- Logic modeling used to determine best attainable & sustainable metrics
- Info is all publically available at:
<https://primis.phmsa.dot.gov/rd/performance.htm>

Website Usage

Website Usage Metric	Measure
Total Number of Hits	17,857,771
Average Number of Hits/Month	129,404
Files Downloaded (since 1/01/2008)	1,108,158



Interagency Research Program Areas & Responsibilities

Programmatic Area	Responsibility					
	DOT		DOC		DOI	
	Onshore	OCS (a)	Onshore (b)	OCS (b)	Onshore	OCS (c)
1. Threat Prevention	X	X				X
2. Leak Detection & Mitigation	X	X				X
3. Anomaly Detection & Characterization	X	X	X	X		X
4. Anomaly Remediation & Repair	X	X				X
5. Design, Materials, & Welding/Joining	X	X	X	X		X
6. Alternative Fuels, Climate Change, & Other	X	X	X	X		X
NOTES:	<p>a. DOT has mutual jurisdiction on Outer Continental Shelf (OCS) transmission pipelines with DOI.</p> <p>b. DOC was identified as a national expert on materials research via PSIA 2002.</p> <p>c. DOI is the primary pipeline regulator in the OCS.</p>					

Competitive Academic Agreement Program (CAAP): Objectives

- Spur innovation through enabling an academic research focus on high risk and high pay-off solutions for the many pipeline safety challenges
- Intended to potentially deliver desired solutions that can be a “hand-off” to further investigations in this or PHMSA’s core research program
- Expose **“students”** to subject matter common to pipeline safety challenges and illustrating how their engineering or technical discipline is highly desired and needed in the pipeline field

CAAP Summary Totals

Annual Announcement	# Awards	PHMSA	Resource Sharing	# U-Grad Students	# Grad Students	# PhD Students	Total # Students
CAAP-1-13	8	\$ 814K	\$ 353K	21	18	13	52
CAAP-2-14	7	\$ 699K	\$ 391K	1	7	5	13
GRAND TOTALS:	15	\$ 1,513K	\$ 745K	22	25	18	65

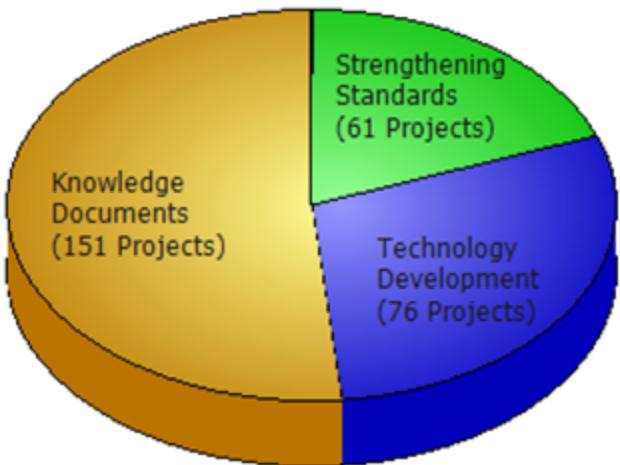


Natural Gas Infrastructure Technical Challenges



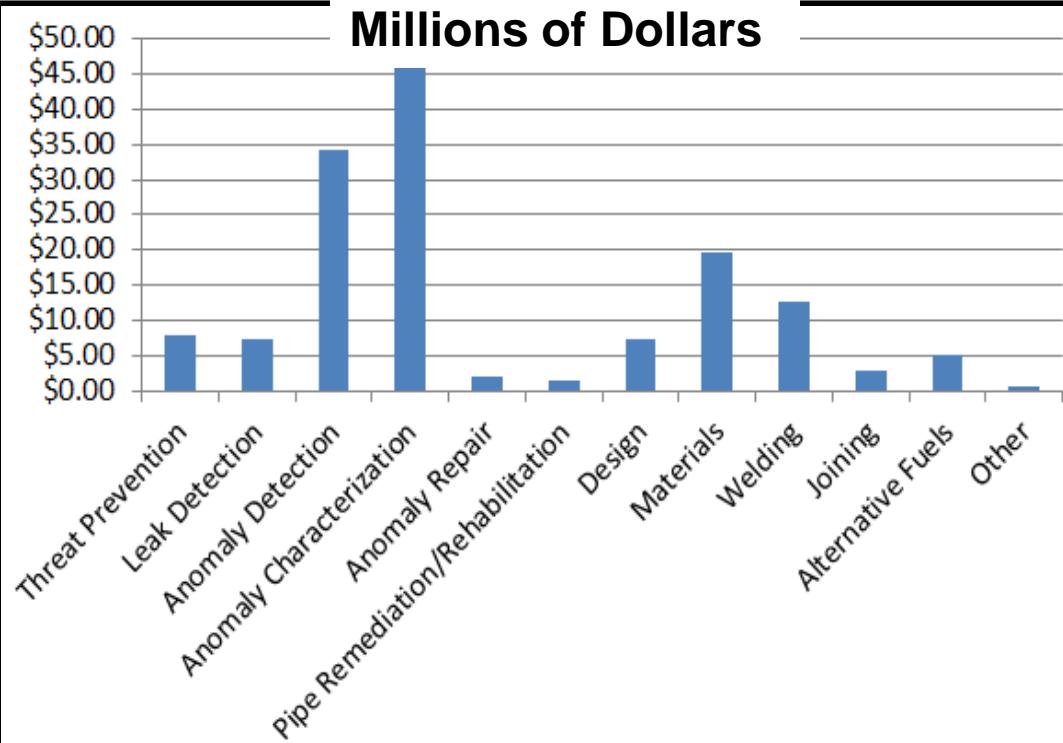
Since 2002

Natural Gas RD&T Investment



Objective	Projects	PHMSA	Co-Share	Total
Strengthening Standards	61	\$25.37M	\$20.38M	\$45.75M
Technology Development	76	\$43.74M	\$43.17M	\$86.91M
Knowledge Documents	151	\$49.11M	\$47.21M	\$96.33M

NOTE: Projects can be relevant to more than one pipeline type.

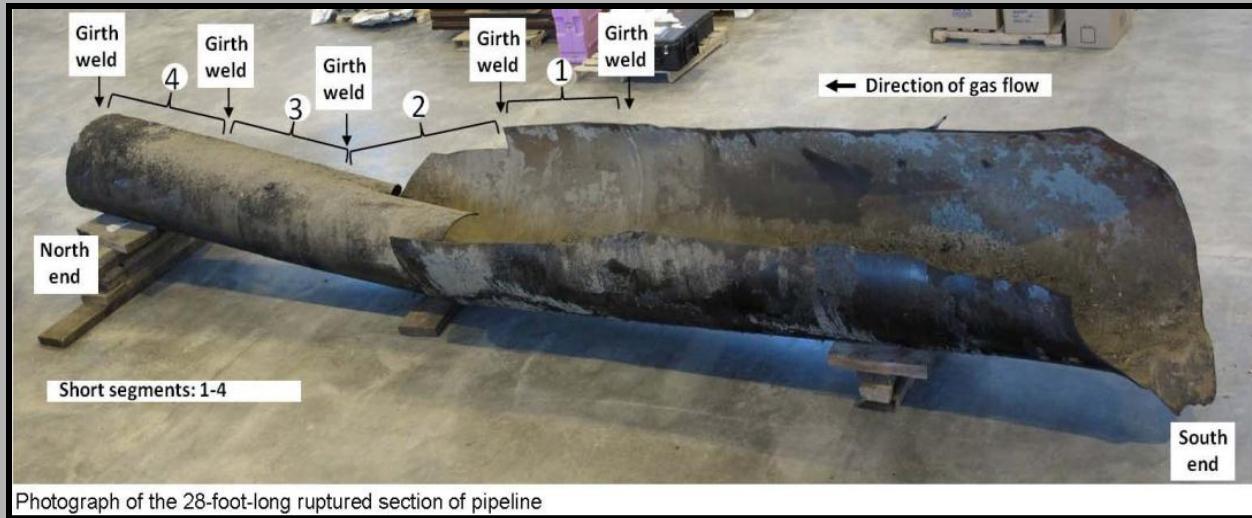


Solicited 6 times for leak detection (LD) projects (not always finding awardable projects). Funded 12 related projects with \$5.7M PHMSA + \$1.6M resource sharing. Impact – 3 NG - LD technologies now in the market today.



Challenge: Pipe Seams

SAW Failure in San Bruno, CA



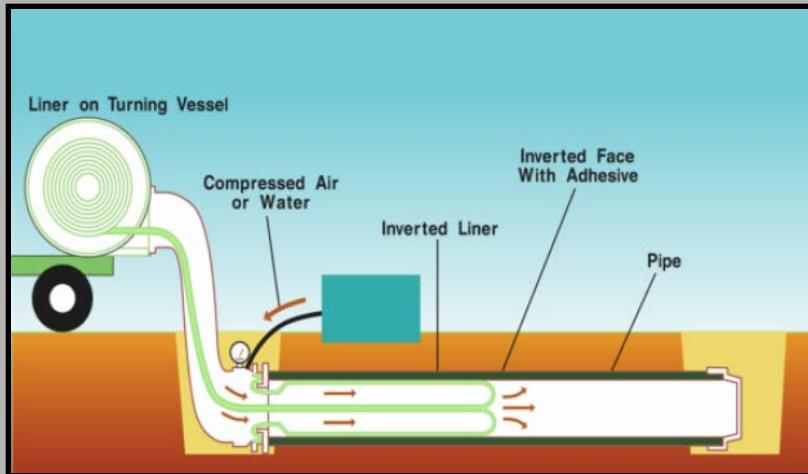
Hydrotest Failure

ERW Seam Failure in Carmichael, MS

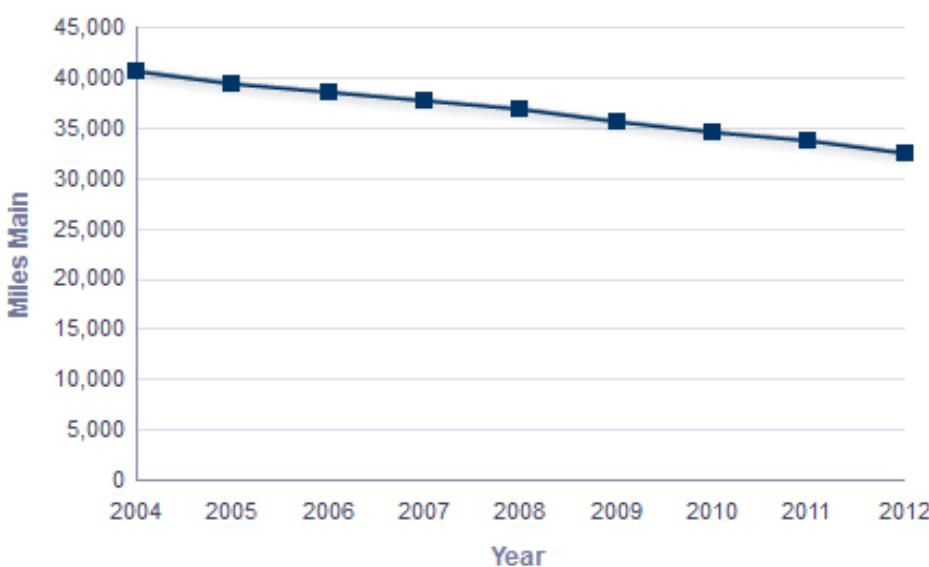




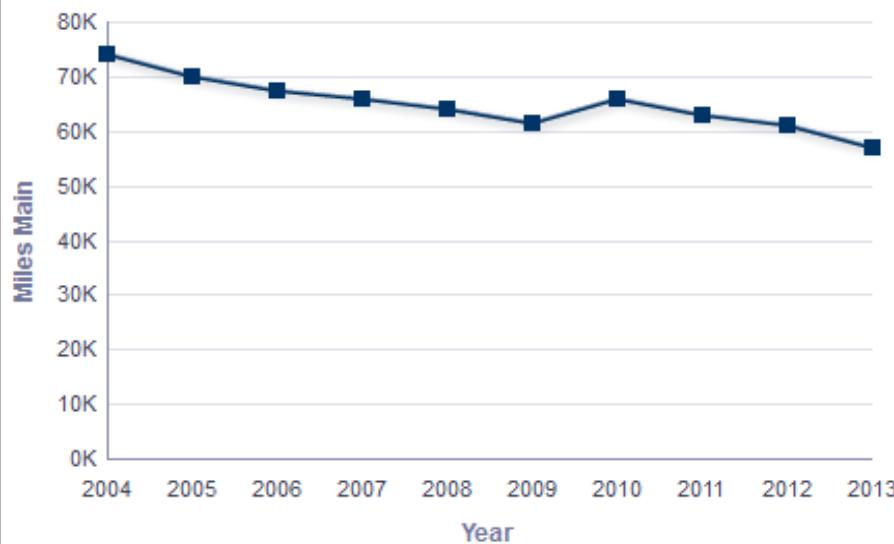
Challenge: Cast Iron



Gas Dist. Cast/Wrought Iron Main Miles



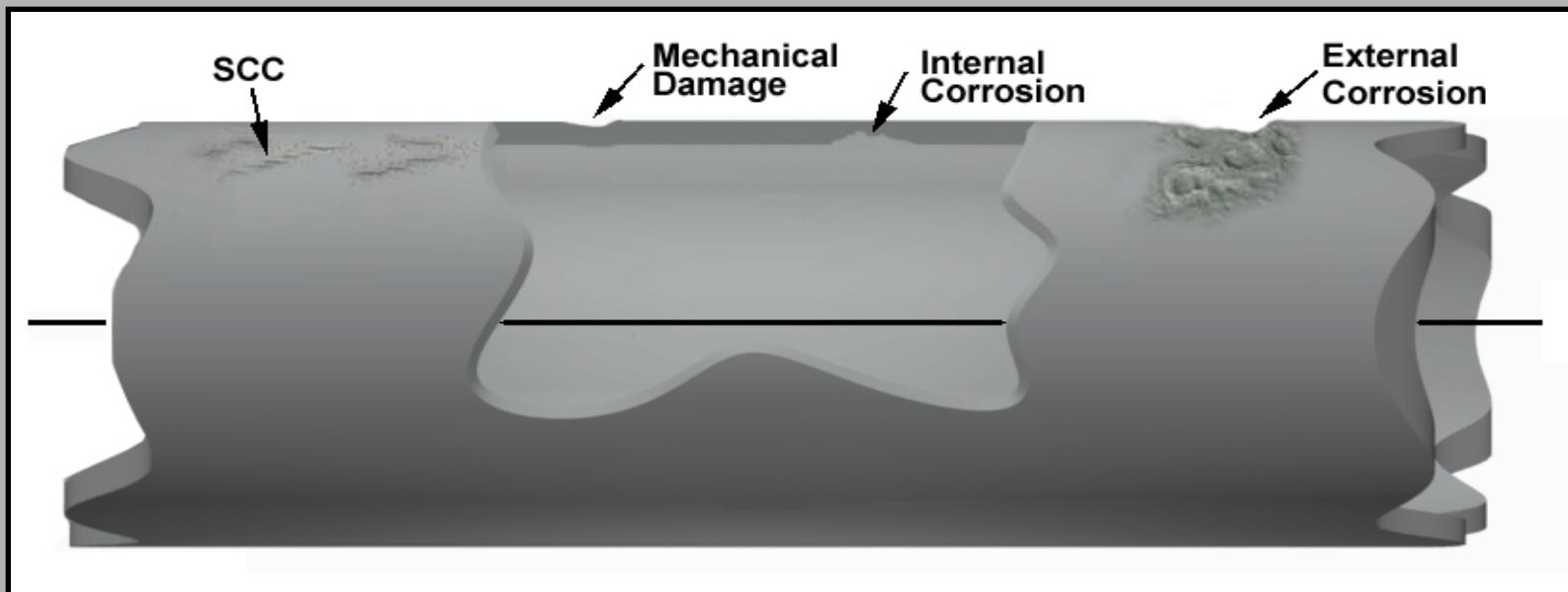
Gas Dist. Bare Steel Main Miles





Challenge: Anomaly Detection

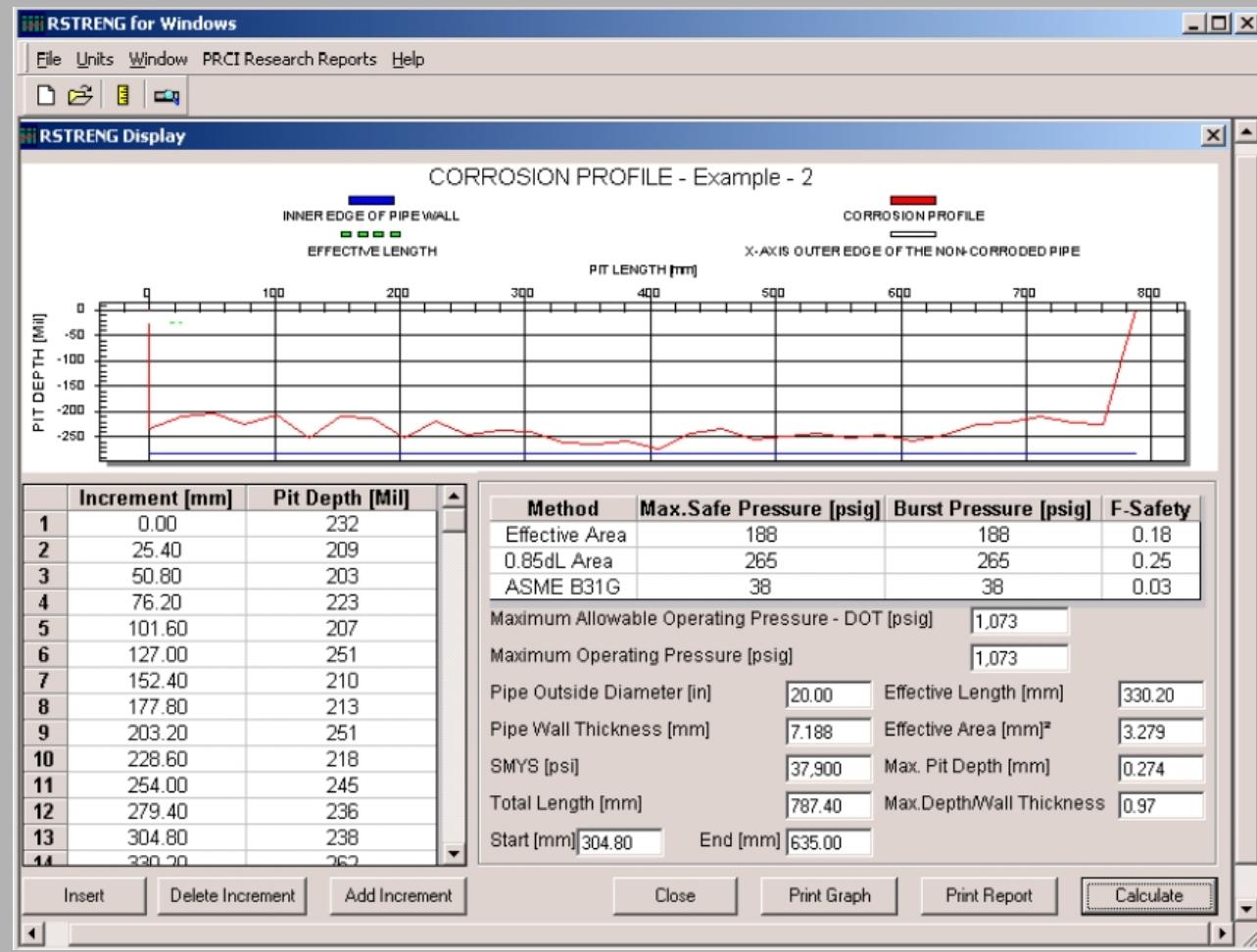
- More accurate tools for In Line Inspection
- More accurate tools for In-Ditch
- More sensor types for robotic ILI of unpiggable systems
- Priority - Cracking & Interactive Threats





Challenge: Anomaly Characterization

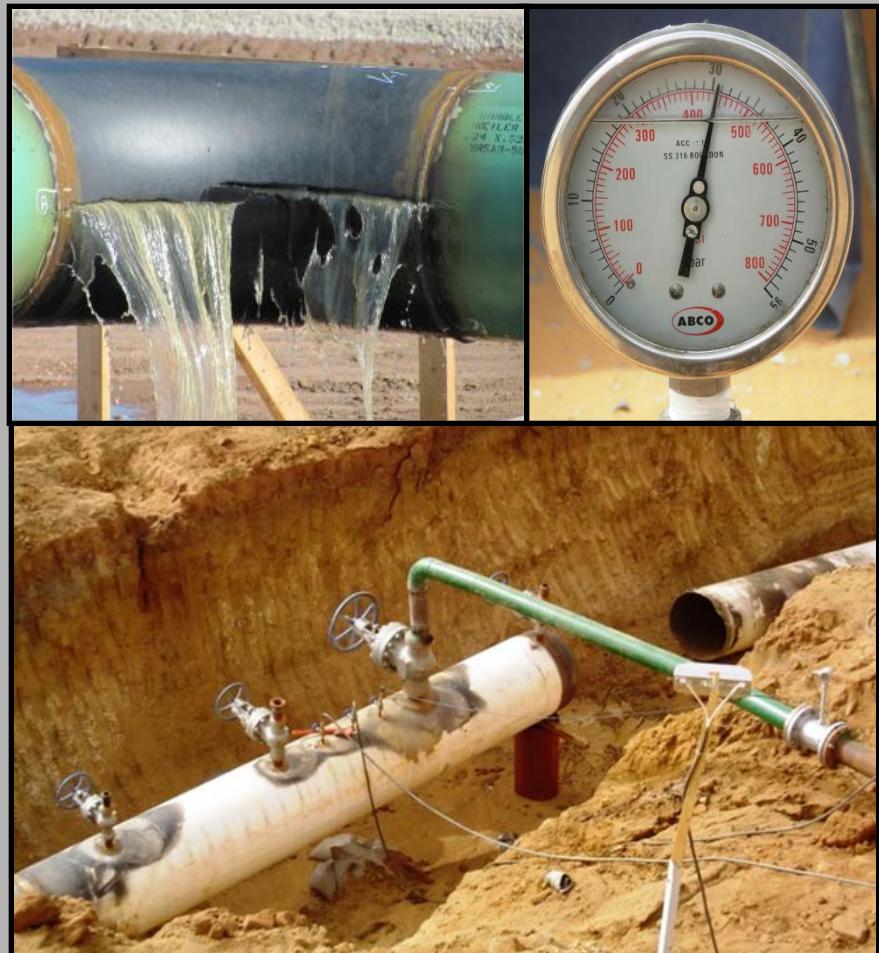
- Need to progress beyond simple loadings
- Need complex loading models to address interactive threats





Replacing Hydrotesting?

- **Why hydro? What benefits?**
 - Pressure & Spike Tests
- **Can ILI tools in concert with leak detection surveys replace a hydro?**
 - Cracking especially in the seam not well detected or sized – R&D underway
 - ILI can't identify understrength materials
- **NTSB & Congress – strong hydro focus to PHMSA**
 - Recommendations/Mandates



Stakeholder Driven

- **What are the right priorities?**
 - R&D Forum generates national research agenda
 - Leverages through coordination and reduces duplication
- **Pipeline R&D Forum Aug 2014**
https://primis.phmsa.dot.gov/rd/mtg_080614.htm
 - Approx 230 reps & now soliciting 17 topics – awards by Feb 2015
 - <https://primis.phmsa.dot.gov/matrix/RfpInfo.rdm?rfp=51>
 - Threat Prevention, Leak Detection/Fugitive Methane, Anomaly Detection & Characterization, Materials, Risk Models and LNG
- **Pipeline R&D Forum July 2012**
https://primis.phmsa.dot.gov/rd/mtg_071812.htm
 - Approx 215 reps – solicited 20 topics funded 21 research projects



Fugitive Methane: Thoughts, Actions and Research Suggestions



Fugitive Methane

- PHMSA closely following issues and policy development by others
 - White House, Congress and Industry Trade Orgs.
- Coordinating with EPA with meetings and PHMSA participation at EPA Gas Star Program events
- Coordinating with the Environmental Defense Fund efforts and added EDF representation on PHMSA's congressionally mandated Pipeline Advisory Committee
- Reviewing natural gas regulations to understand leak paths and possible actions germane to our statutory mission
 - However, safety case largely already made in support of hazardous leak reductions
 - Remaining non-hazardous leaks generally economic in nature
 - NARUC, FERC and the Congress



Methane Related PHMSA Actions

- **Overall Regulatory Program** – Keeping product in the pipeline and preventing leaks has the ancillary benefit of reducing emissions
- **Integrity Management (IM) Rulemaking** – Enhanced transmission industry programs to find and fix leaks since 2004
- **Distribution IM Program Rulemaking** – Requirements to find and fix leaks in the distribution system since 2011





Methane Related PHMSA Actions

- **Research & Development** – A collaborative and co-funded program since 2002 is bringing several technology solutions to market
 - Tools for Reducing failure rates
 - Tools for Minimizing leaks
- **Excess Flow Valves** – Mandatory installation of EFVs on new and replaced residential service
- **Increasing Pipeline Capacity** – Conducted rulemaking to improve throughput efficiency in cross border pipelines – 72% to 80% SMYS



Potential Methane Leak Paths

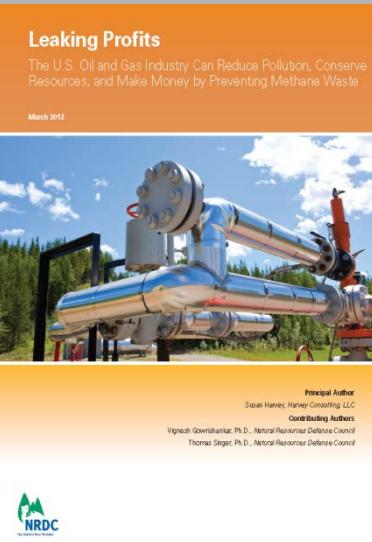
- **Natural Gas Gathering, Transmission, Distribution and LNG systems**
 - Piping (various), Flanges, Gaskets, Meters, Compressors, Line Valves (various), Relief Valves, Drip Traps, Pig Launchers/Receivers, etc.
 - Gas permeation – constituents of natural gas are somewhat permeable through PE/PA pipe
 - Leak rates vary due to...
 - Gas pressure, quality, temperature, dew point, etc. & Pinhole leak or full rupture



Potential Methane Leak Paths

- **Natural Gas Gathering, Transmission, Distribution and LNG systems**
 - Example of Challenge - Pressure relief devices that vent gas have a major safety function and can't be easily eliminated
 - Perhaps capture gas?
- **Hazardous Liquid Systems**
 - Vapor from Breakout Tanks

Research Suggestions - DOE



- Questionable value of much more methane detection research
 - Dozens of companies now offering service – Google it and see!
 - Leverage prior/ongoing PHMSA, Industry tech successes and factor ARPA-E coming investments
- These two reports via the EDF spell out a variety of energy supply chain options for reducing methane
- Research in these suggested areas can:
 - Improve economics of existing products/technology
 - Develop new technology and more options for the industry to consider





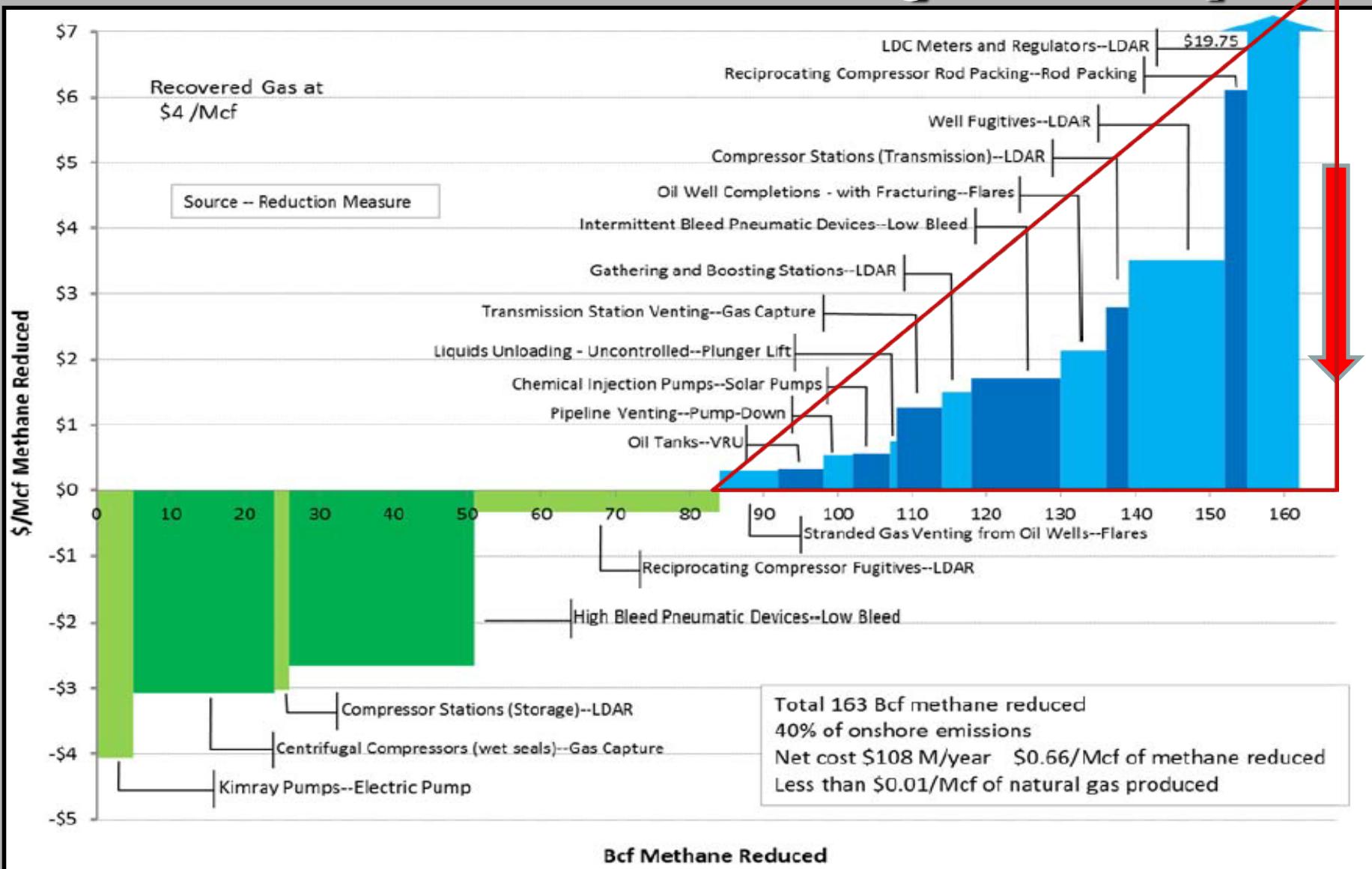
EDF – Leaking Profits Report



1. **Green Completions** to capture oil and gas well emissions
2. **Plunger Lift Systems** or other well deliquification methods to mitigate gas well emissions
3. **Tri-Ethylene Glycol (TEG) Dehydrator Emission Controls** to capture emissions from dehydrators
4. **Desiccant Dehydrators** to capture emissions from dehydrators
5. **Dry Seal Systems** to reduce emissions from centrifugal compressor seals
6. **Improved Compressor Maintenance** to reduce emissions from reciprocating compressors
7. **Low-Bleed or No-Bleed Pneumatic Controllers** used to reduce emissions from control devices
8. **Pipeline Maintenance and Repair** to reduce emissions from pipelines
9. **Vapor Recovery Units** used to reduce emissions from storage tanks
10. **Leak Monitoring and Repair** to control fugitive emissions from valves, flanges, seals, connections and other equipment



EDF – Economic Analysis Report





PHMSA Research Focus on Fugitive Methane

**Refine/Enhance/Develop Methane Leak Survey
Technologies and Methodologies to Quantify Detected
Emissions from Relatively Small Volume Rate Leaks to
Prioritize a Remedial Action Plan**

- EDF/EPA/DOE, 2 dozen plus operators and tech vendors helped craft the topic
- Facets of this topic:
 - Focus on volumetric measurement of non-hazardous leaks
 - Utilize industry leak grading system
 - Develop framework to integrate leak and other required information into remedial plan – **Dovetails with other R&D!**

Award(s) anticipated by Feb 2015.

PHMSA Research Focus on Cast Iron

Research Goal - Support prioritizing replacement of higher risk cast iron pipe

- Ongoing research work with detecting graphitic corrosion and post mortem analysis on Cured in Place Liners
- New Research commencing by Feb 2015 on:
 - Structural Evaluation of Corroded Cast Iron Pipe
 - Engineering Critical Assessment of Cured in Place Pipe Liners at Bends, Valves and Service Taps
 - Goes beyond ongoing CIPL work

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PHMSA RD&T Providing/Supporting:

LEADERSHIP

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COMMERCIALIZATION