

U.S. DOT

Pipeline and Hazardous Materials Safety Administration



August 29, 2019

**William (Bill) Lowry, PE
Community Liaison**



Today's Agenda

- **Performance Measures/ Data & Statistics**
- **Pipeline Safety Research Development & Technology: Competitive Academic Agreement Program (CAAP)**
- **Risk Based Inspection Process**
- **Pipeline Technical Resources & other web resources**



PHMSA Regulated Pipeline Facilities OPS and States

Pipeline Facilities by System Type				
System Type		Miles	% Miles	# Operators
Hazardous Liquid	CY 2017	215,817 8,118 Tanks	8%	531
Gas Transmission	CY 2018	301,147	11%	1,045
Gas Gathering	CY 2018	17,556	1%	344
Gas Distribution	CY 2018	2,234,528	80%	1,283

Total Miles	2,769,048
--------------------	------------------

Liquefied Natural Gas CY 2018	157 Plants, 228 Tanks, 86 Operators Plants - 27 Interstate and 130 Intrastate
Underground Natural Gas Storage CY 2018	397 Facilities, 451 Reservoirs 17,281 Wells, 124 Operators Facilities - 221 Interstate and 176 Intrastate

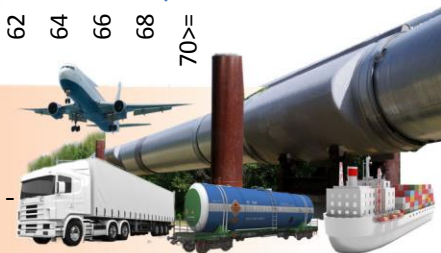
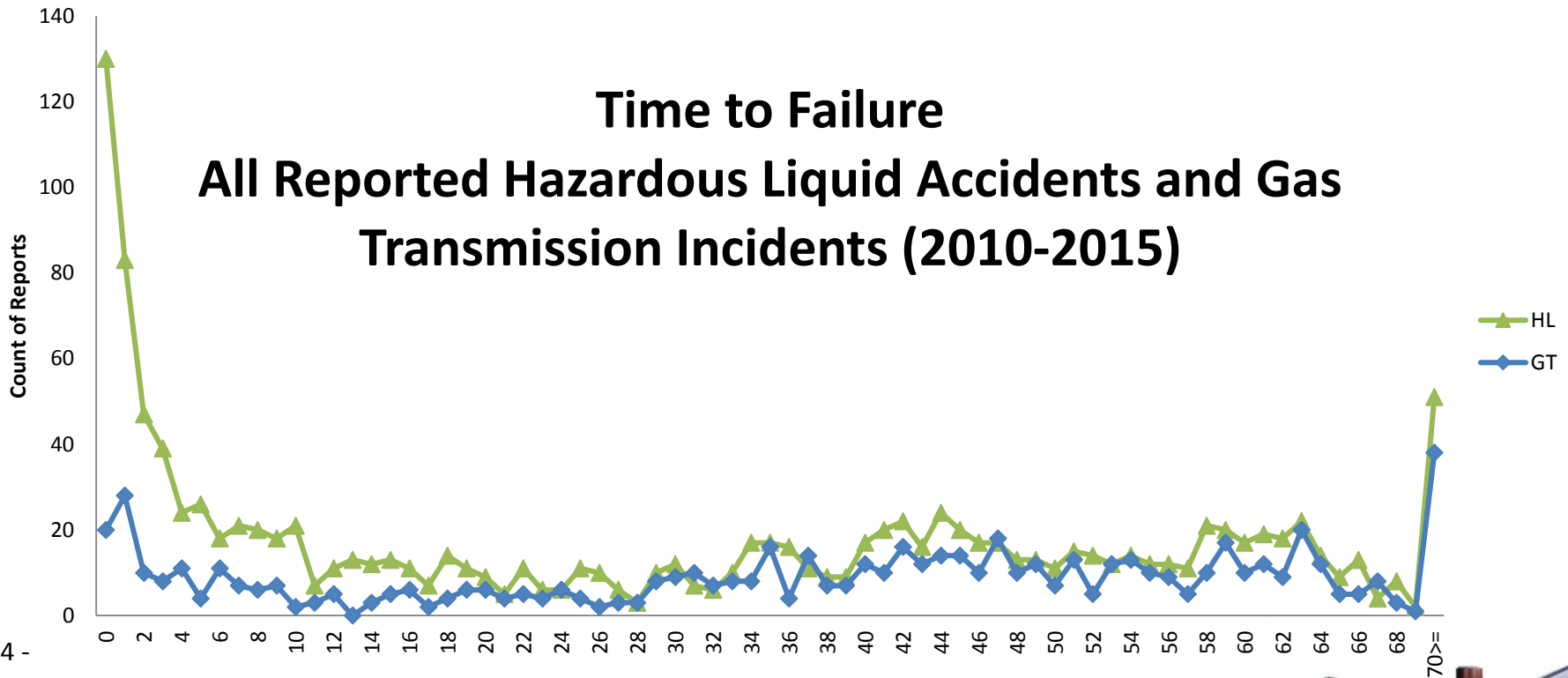
data as-of 3-27-2019



Today's Environment

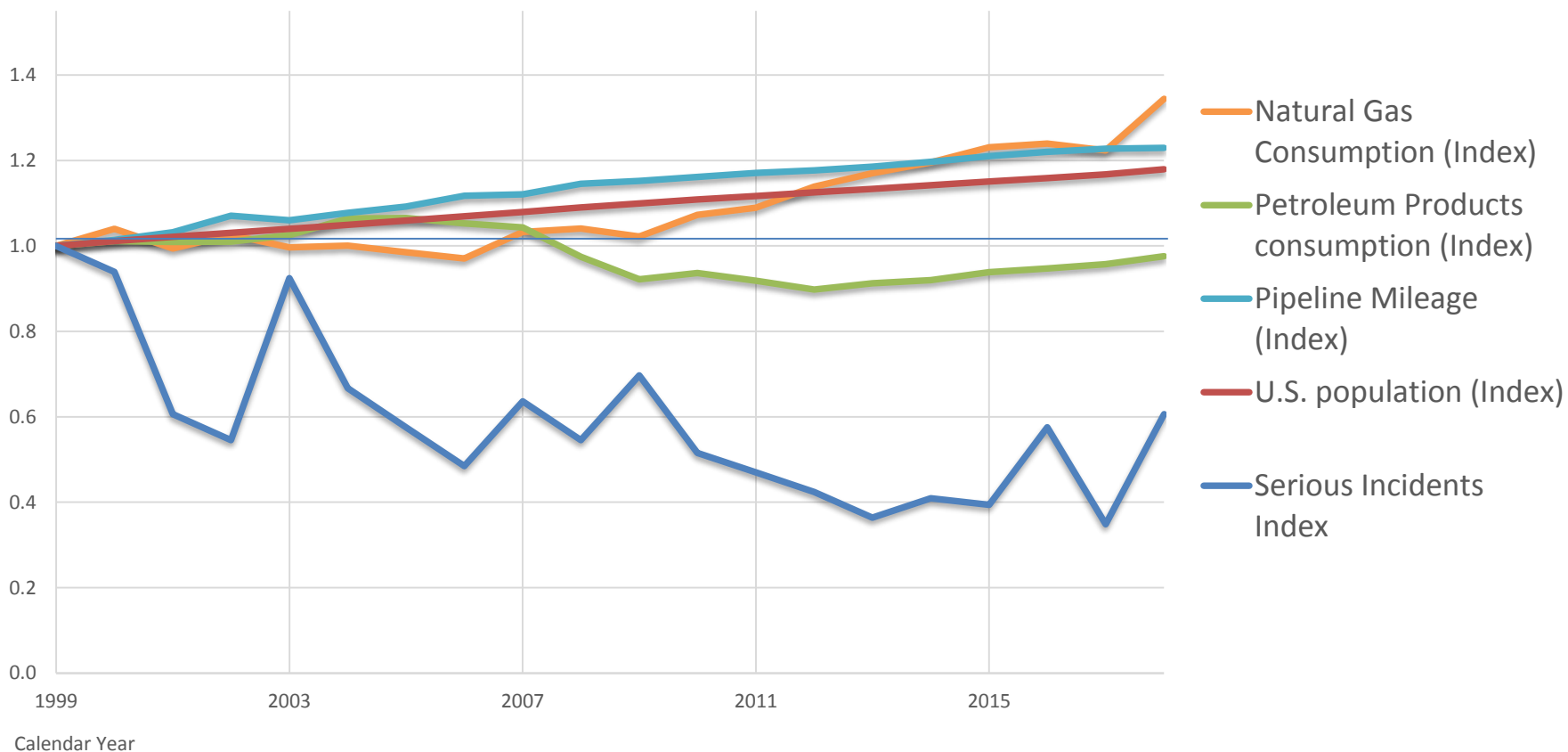
- Aging infrastructure
- Expanding new infrastructure

Time to Failure
All Reported Hazardous Liquid Accidents and Gas Transmission Incidents (2010-2015)



Pipeline Serious Incidents with Context Measures (1999-2018)

Index
(1999 = 1)



Data Sources: Energy Information Administration, Census Bureau, PHMSA Annual Report Data, PHMSA Incident Data - as of 03/18/2019
EIA data preliminary for 2018



Data and Statistics

The data and statistics are publicly available at:

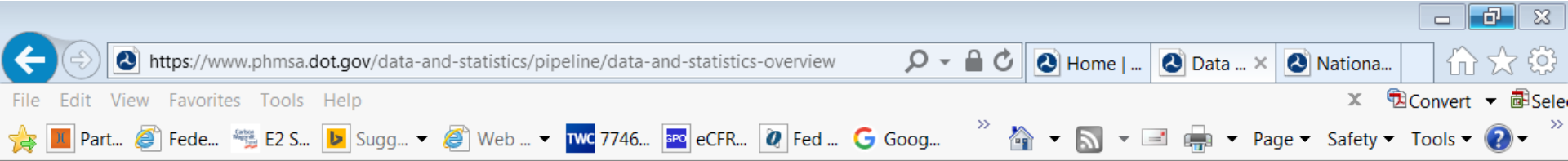
<https://www.phmsa.dot.gov/data-and-statistics/pipeline/data-and-statistics-overview>

Performance Measurement

<https://www.phmsa.dot.gov/data-and-statistics/pipeline/national-pipeline-performance-measures>



Data and Statistics



United States Department of Transportation

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Pipeline and Hazardous Materials
Safety Administration



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[SAFETY](#)

[REGULATIONS AND COMPLIANCE](#)

[RESOURCES](#)

Home » Data and Statistics » Pipeline

Data and Statistics
Overview

Pipeline Operator Safety
Program Data

National Pipeline
Performance Measures

State Pipeline
Performance Measures

Pipeline Replacement
Updates

Federal Enforcement
Transparency

Operator Information

National Pipeline
Mapping System

Data and Statistics Overview

PHMSA's Office of Pipeline Safety (OPS) provides a variety of data about federally-regulated and state-regulated natural gas pipelines, hazardous liquid pipelines, and liquefied natural gas (LNG) plants. The operators of these pipeline facilities report this data in accordance with [Part 191](#) and [Part 195](#) of PHMSA's [pipeline safety regulations](#). PHMSA provides downloads of the raw data, yearly summaries, multi-year trends of safety performance metrics, and inventories tracking the removal of aging and other higher-risk infrastructure.

Frequently Requested Data

[Pipeline Mileage and Facilities](#)

[Pipeline Incident Flagged Files](#)

Contact Us

Pipeline Data and Statistics

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

1200 New Jersey Avenue, SE
Washington, DC 20590

United States

PHMSAPHPDataandStatistics@dot.gov

Phone: 202-366-4595

Business Hours:

9:00am-5:00pm ET, M-F



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

"To protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives."



100%

PHMSA

Pipeline and Hazardous Materials Safety Administration

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Data and Statistics Overview

Pipeline Operator Safety Program Data

National Pipeline Performance Measures

State Pipeline Performance Measures

Pipeline Replacement Updates

Federal Enforcement Transparency

Operator Information

National Pipeline Mapping System

[SERIOUS INCIDENT 20 YEAR TREND](#) - Serious Incidents include a fatality or injury requiring in-patient hospitalization. From 2004 forward, gas distribution incidents caused by a nearby fire or explosion that impact the pipeline system are excluded.

[SIGNIFICANT INCIDENT 20 YEAR TREND](#) - Significant incidents are those including any of the following conditions, but gas distribution incidents caused by a nearby fire or explosion that impacted the pipeline system are excluded:

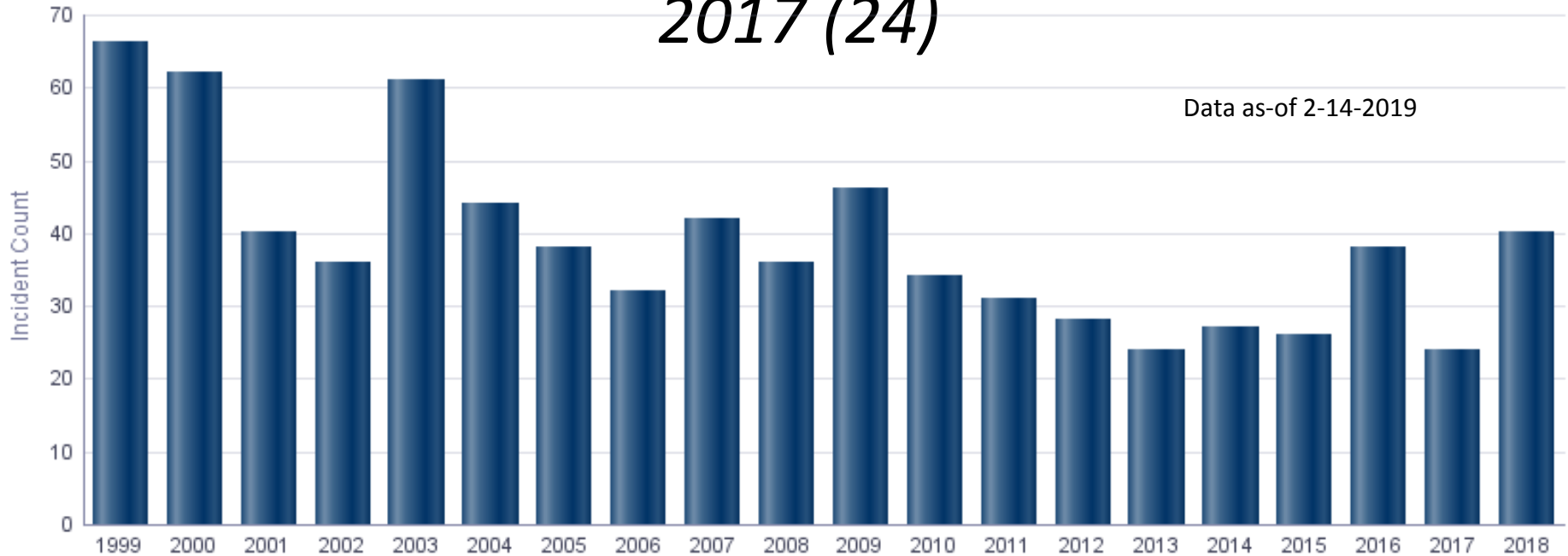
1. Fatality or injury requiring in-patient hospitalization
2. \$50,000 or more in total costs, measured in 1984 dollars
3. Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
4. Liquid releases resulting in an unintentional fire or explosion

[ALL REPORTED INCIDENT 20 YEAR TREND](#) - Includes all reports



Serious Incidents

Serious incidents in 2018 (40) increased 67% from 2017 (24)



40 in CY 2018

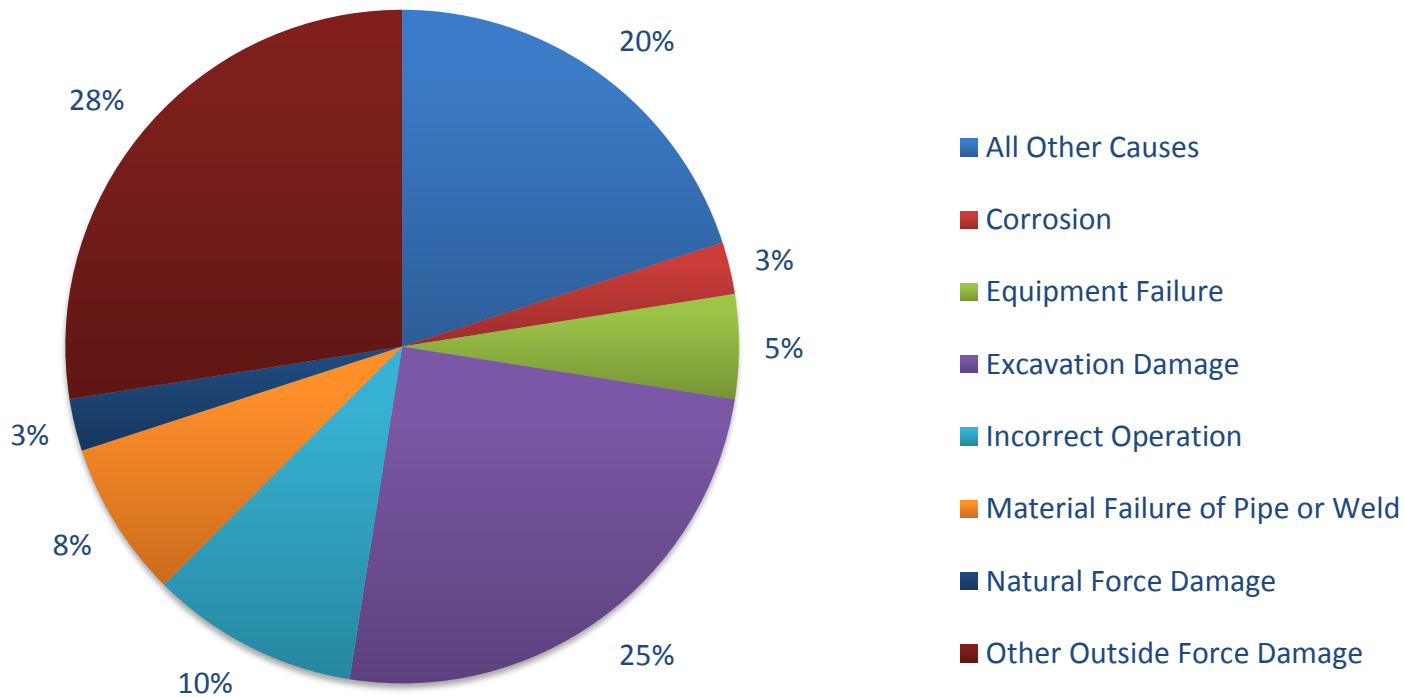
90%	Gas Distribution	7.5%	Gas Transmission
2.5%	Hazardous Liquid	0%	LNG, Gas Gathering, Underground Natural Gas Storage



2018 Serious Incidents by Cause

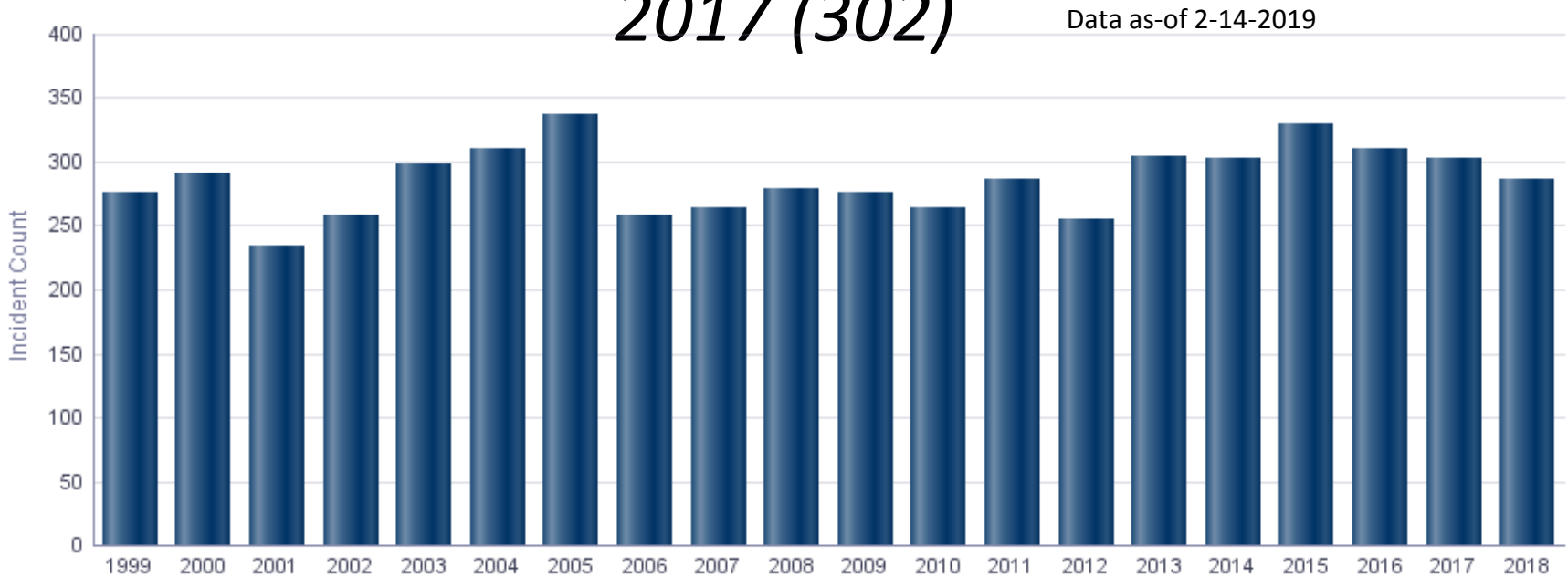
CY 2018 Leading Causes:
Other Outside Force Damage
Excavation Damage
All Other Causes

data as-of 3-1-2019



Significant Incidents

Significant Incidents in 2018 (285) declined 6% from 2017 (302)



285 in CY 2018

26% Gas Distribution

21% Gas Transmission

<1% LNG

<1% Gas Gathering

52% Hazardous Liquid

<1% Underground NG Storage



2018 Significant Incidents by Cause

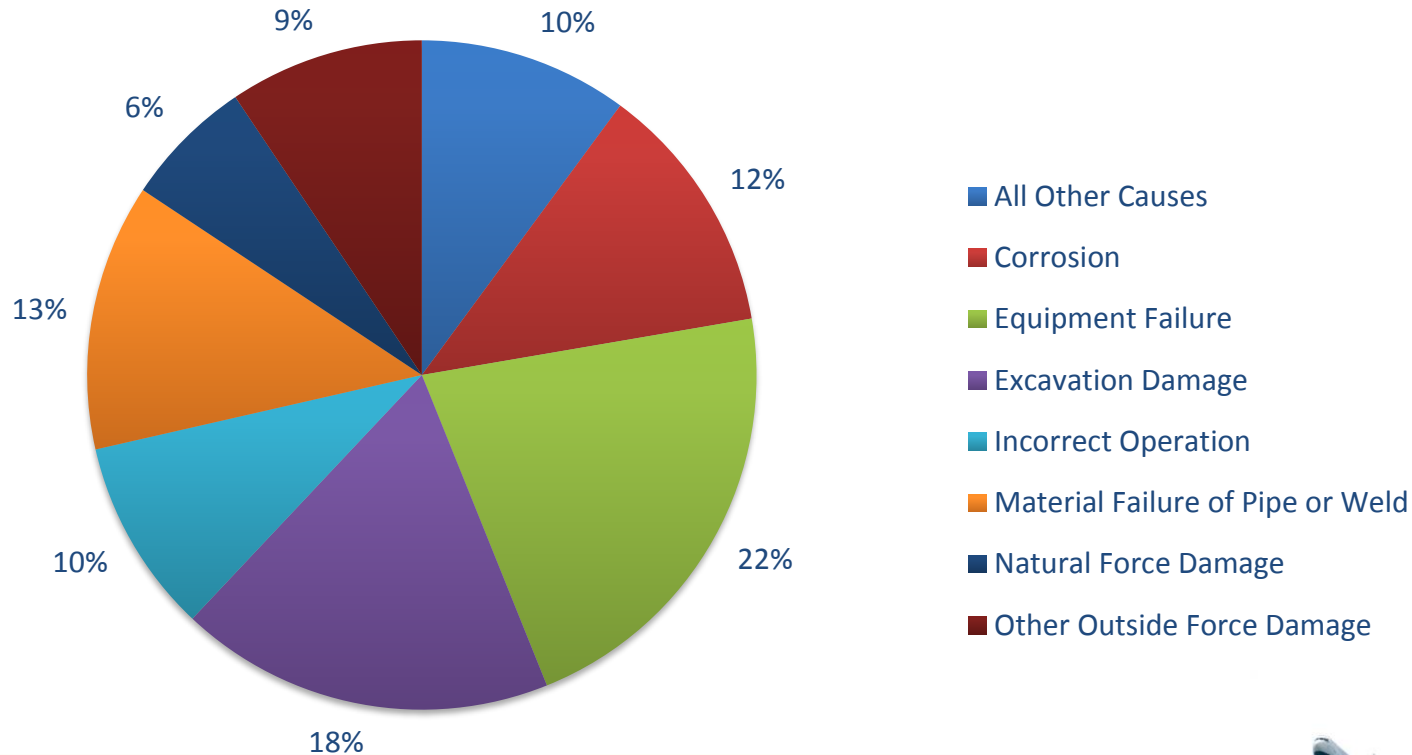
CY 2018 Leading Causes:

Equipment Failure

Excavation Damage

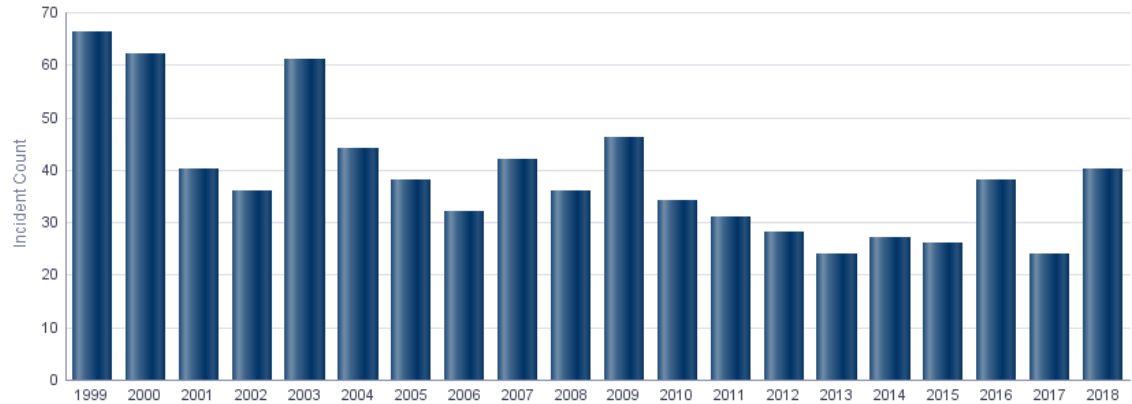
Material Failure of Pipe or Weld

data as-of 3-1-2019

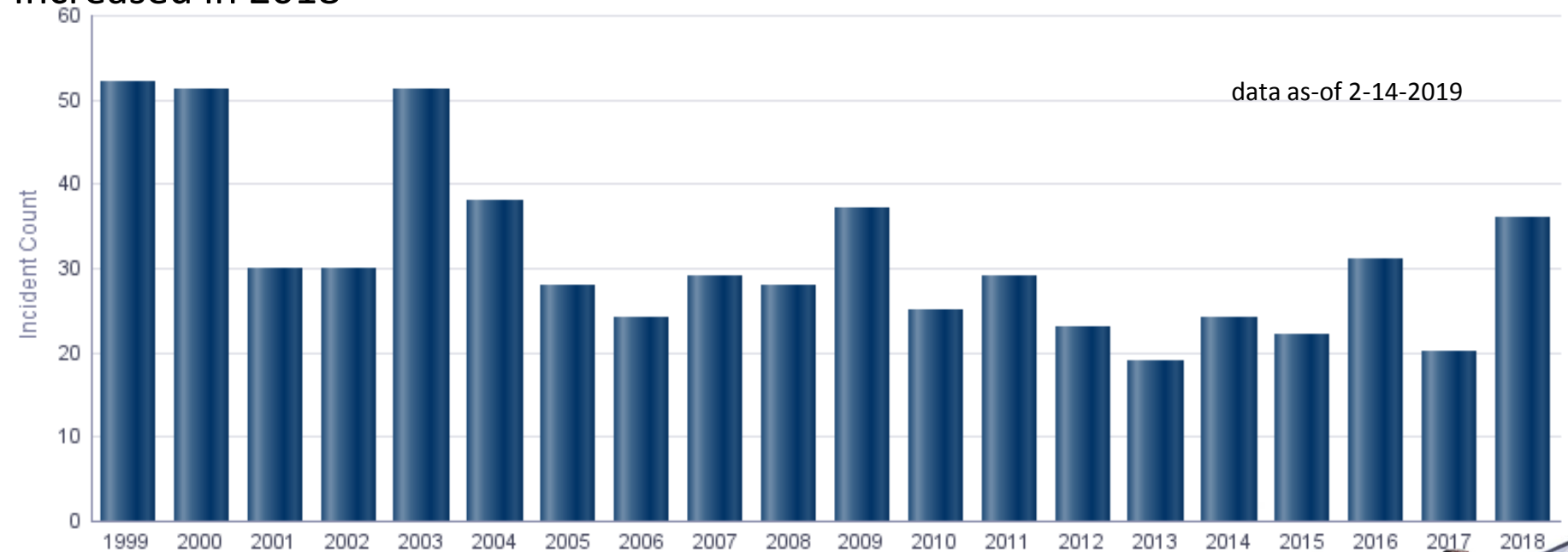


Gas Distribution Serious Incidents

All System Types
Increased in 2018



Gas Distribution
Increased in 2018



Gas Distribution Serious Incidents

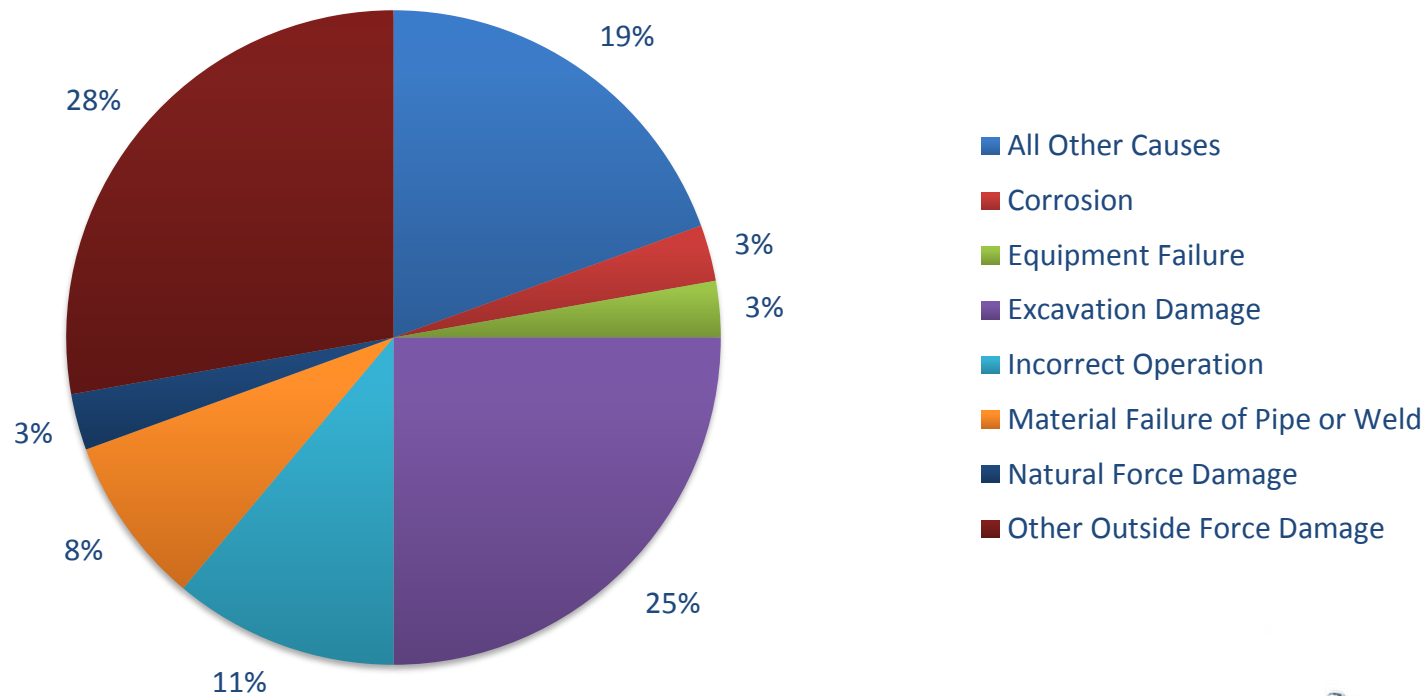
CY 2018 Leading Causes:

Other Outside Force Damage

Excavation Damage

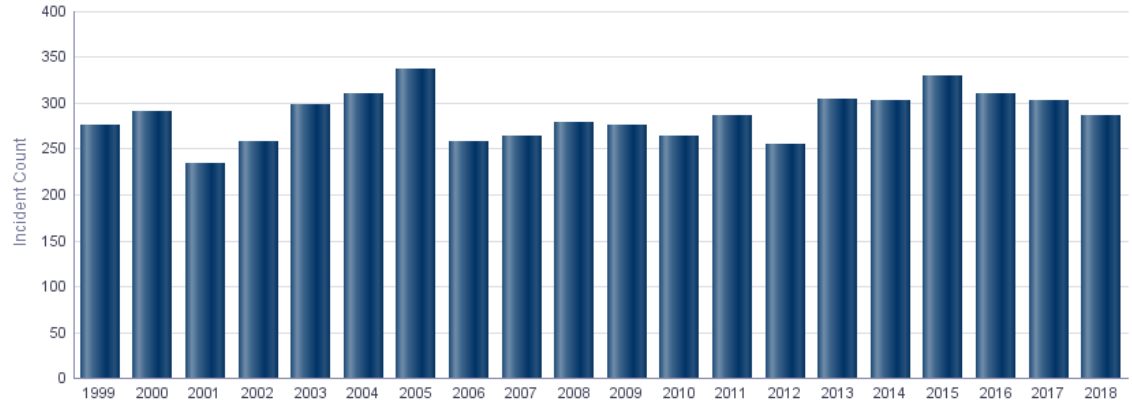
All Other Causes

data as-of 3-1-2019

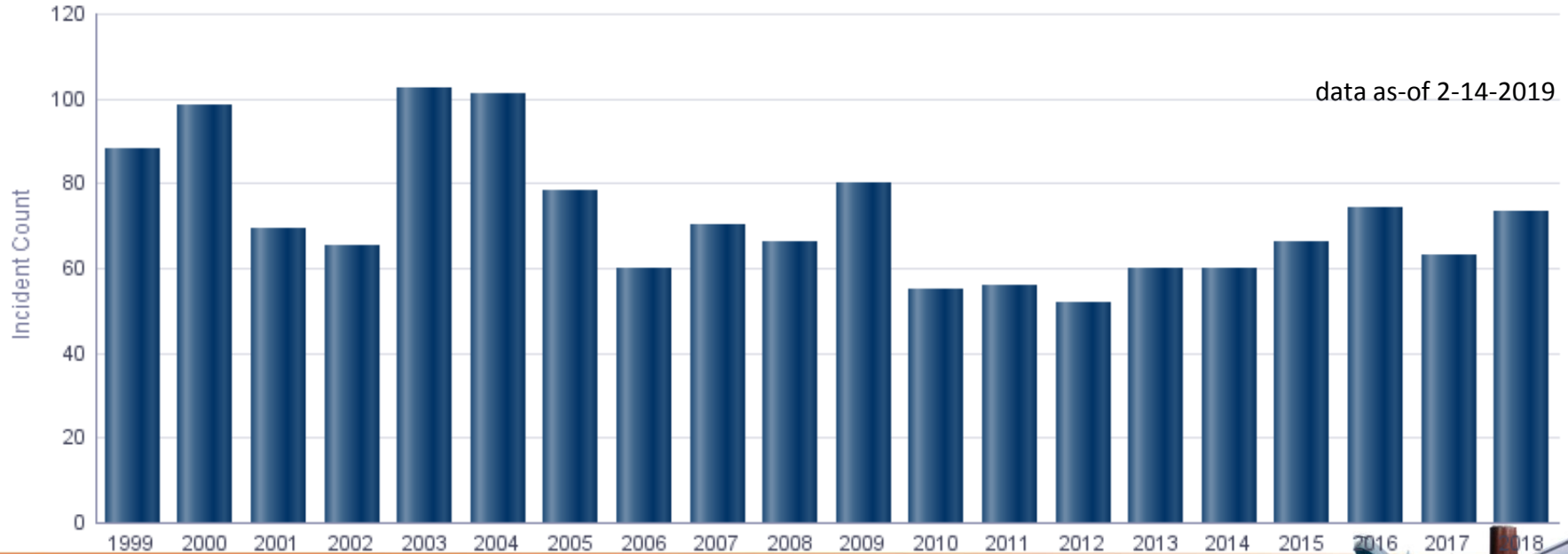


Gas Distribution Significant Incidents

All System Types
Decreased in 2018



Gas Distribution
Increased in 2018



Gas Distribution Significant Incidents

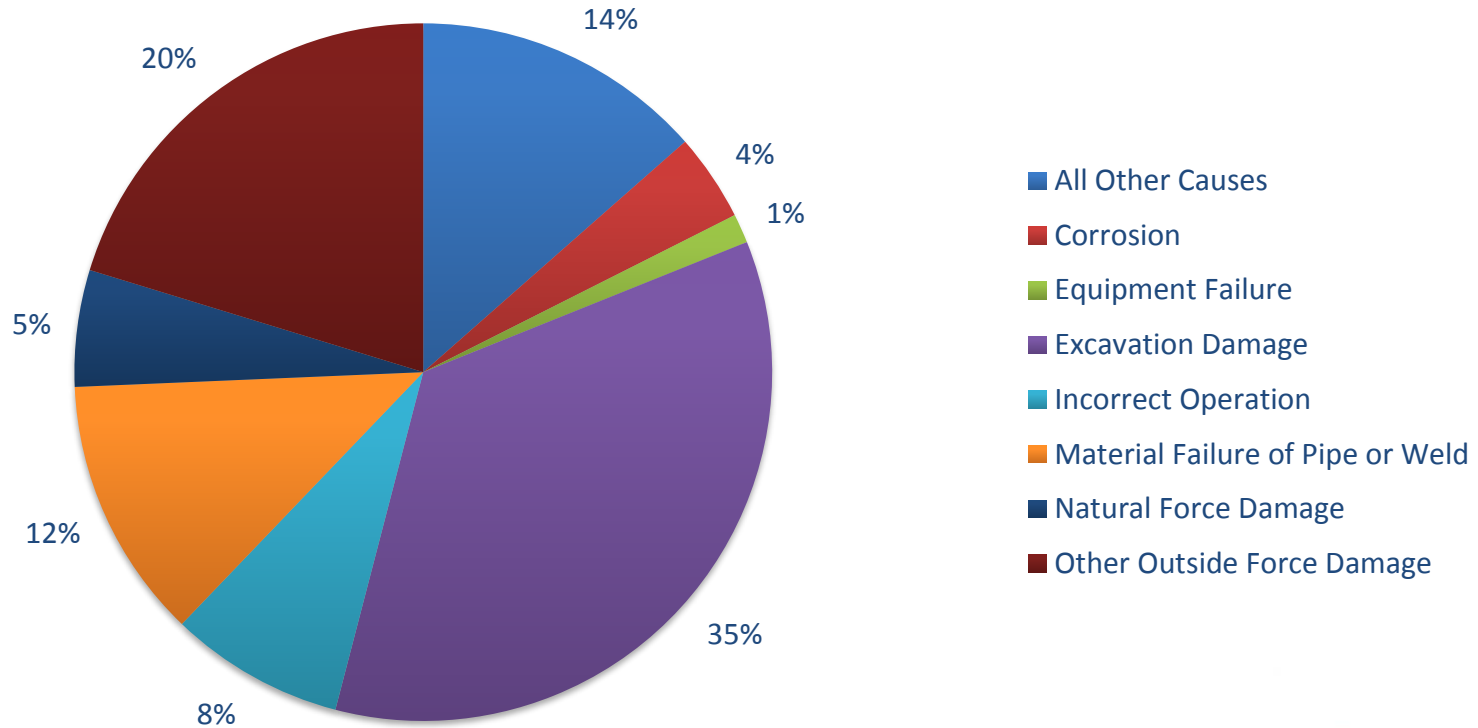
CY 2018 Leading Causes:

Excavation Damage

Other Outside Force Damage

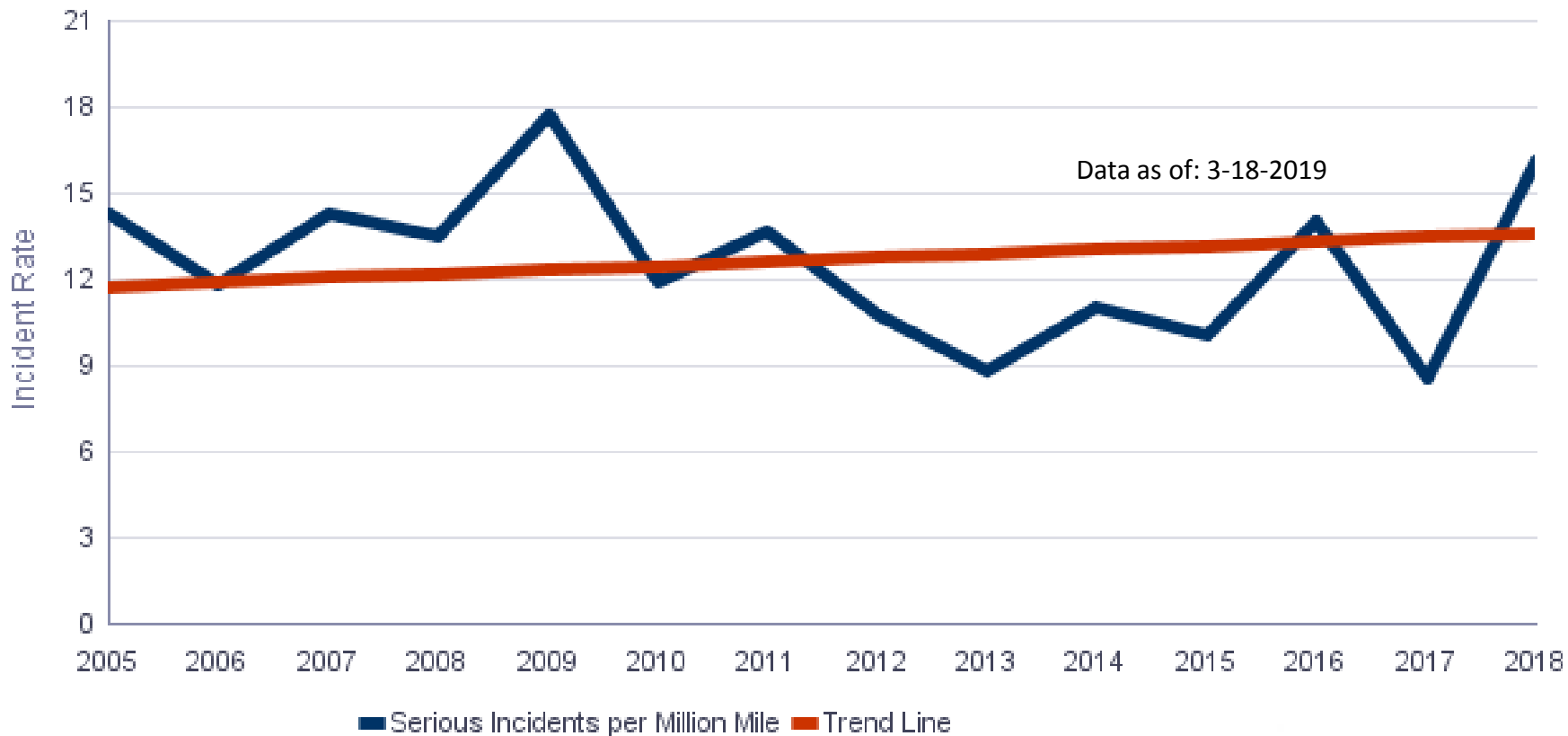
All Other Causes

data as-of 3-1-2019



Gas Distribution Serious Incidents per Million Miles 2005-2018

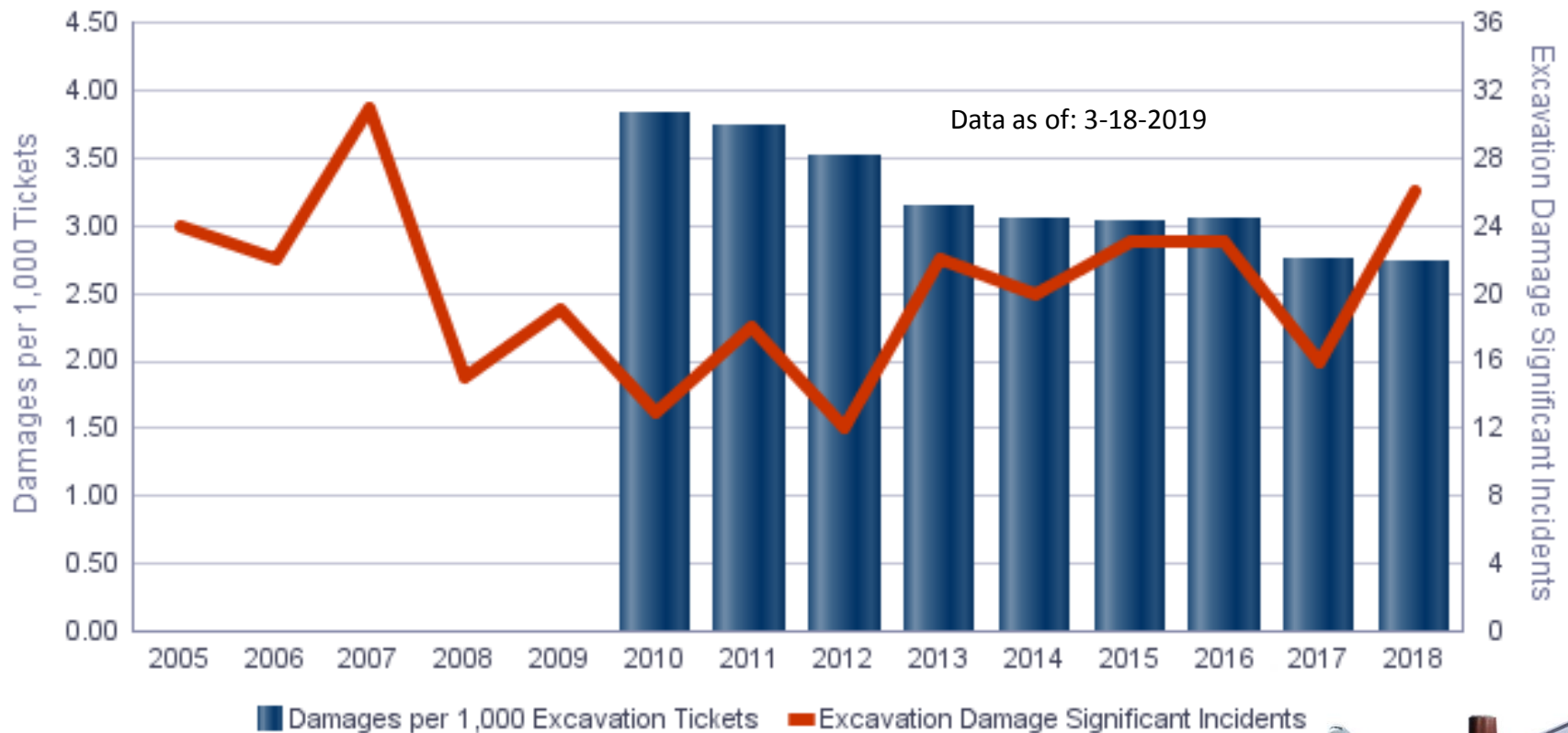
Rate has fluctuated since 2005 with overall increase of 13%



Gas Distribution Excavation Damage 2005-2018

Number of **Significant Incidents** caused by **Excavation Damage** has fluctuated since 2005 and increased 8% overall

Rate of **Damages per 1,000 Tickets** has decreased 29% since 2010



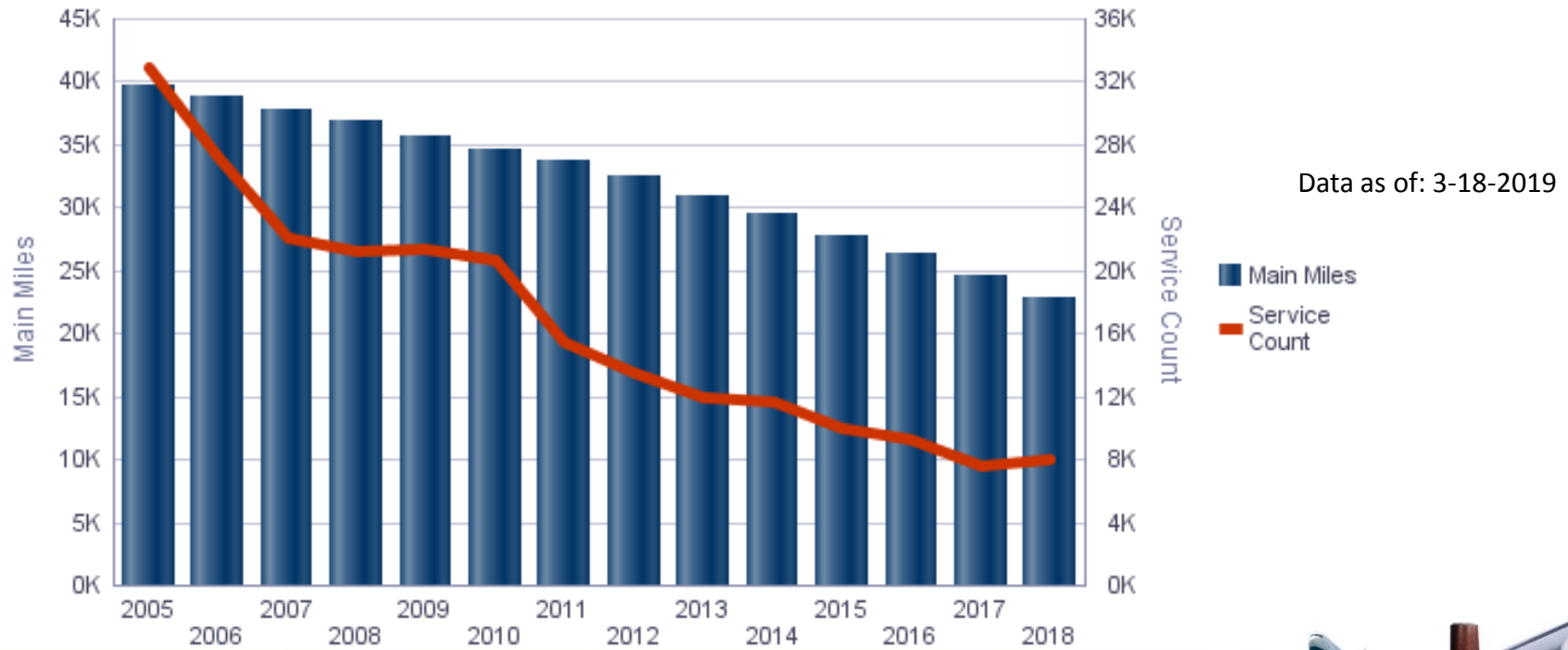
Gas Distribution Cast and Wrought Iron 2005-2018

Cast and Wrought Iron Main Miles have decreased 42% since 2005

Cast and Wrought Iron mains make up 1% of the total gas distribution main miles.

Cast and Wrought Iron Service Count data quality efforts are underway

Less than .1% of all gas distribution services are Cast and Wrought Iron.



Gas Distribution Steel Miles – Bare and Unprotected

2005-2018

Miles of **Bare Steel** has declined steadily since 2005

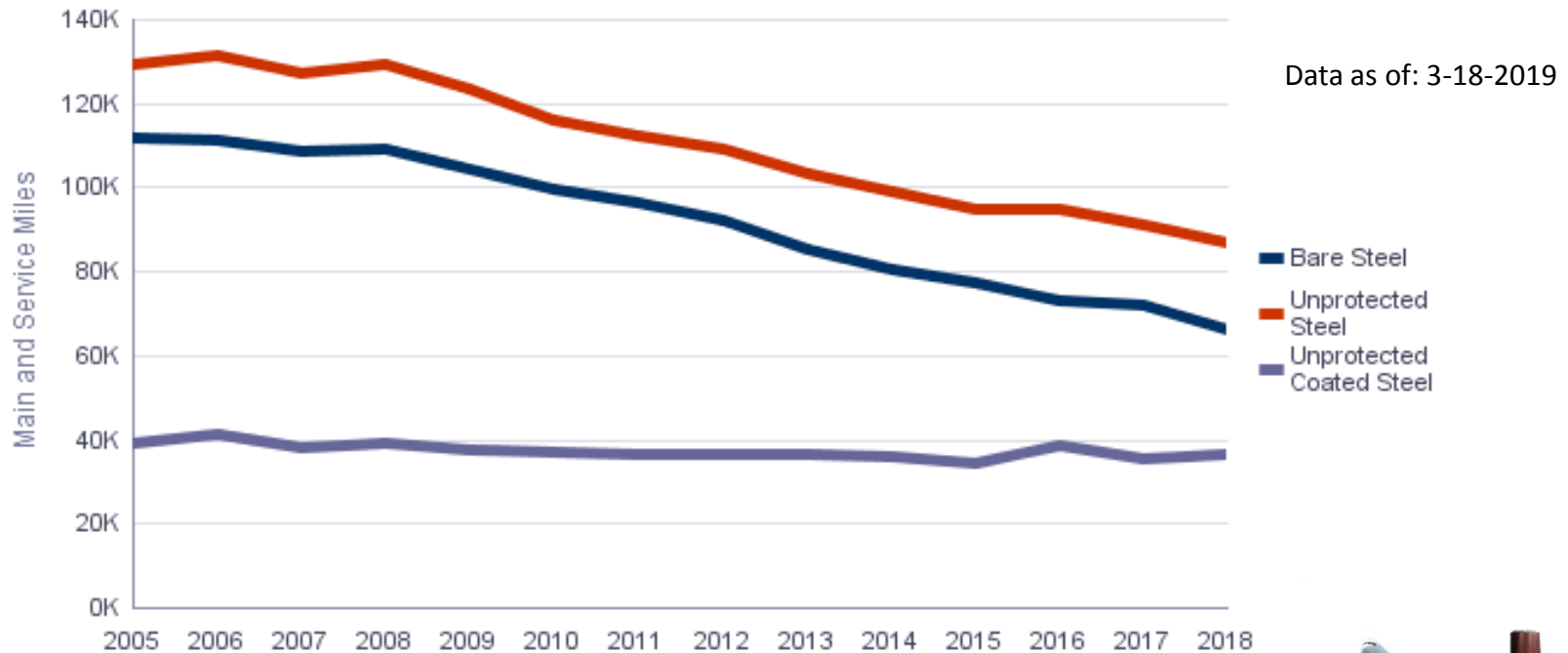
Decrease since 2005 is 40% 3% of gas distribution systems are Bare Steel

Miles of **Unprotected Steel** has declined steadily since 2005

Decrease since 2005 is 33% 4% are Unprotected Steel

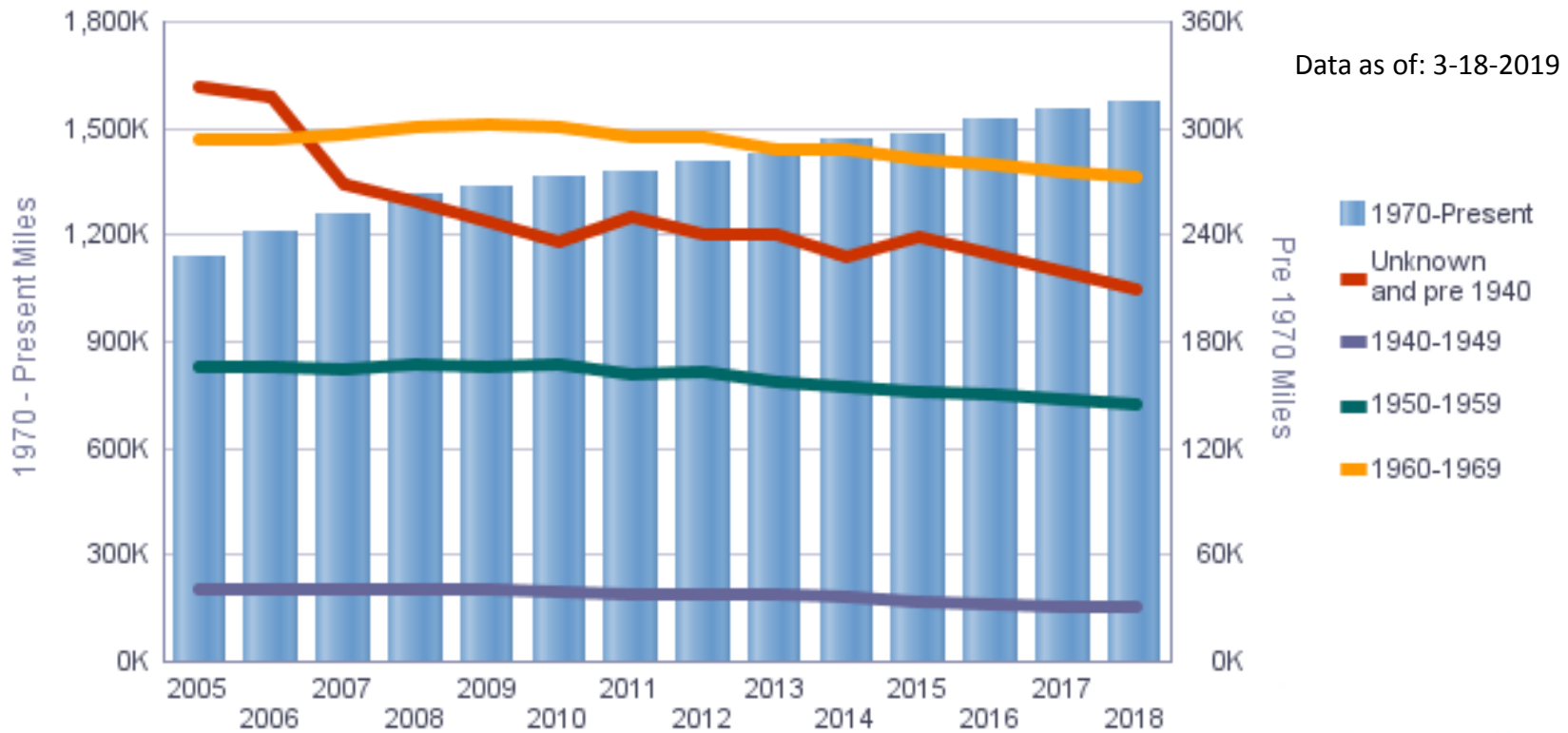
Miles of **Unprotected Coated Steel** has declined since 2005

Decrease since 2005 is 7% 3% are Unprotected Coated Steel



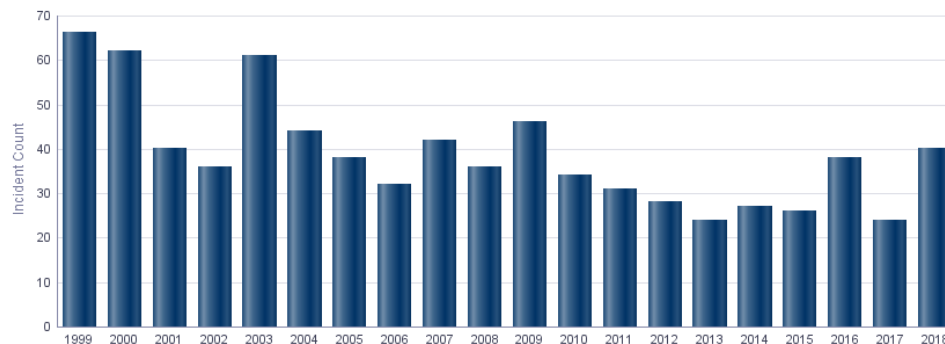
Gas Distribution Miles by Decade Installed 2005-2018

Miles of pipeline system installed **Pre-1970** has declined 20% since 2005
29% of gas distribution systems were installed Pre-1970

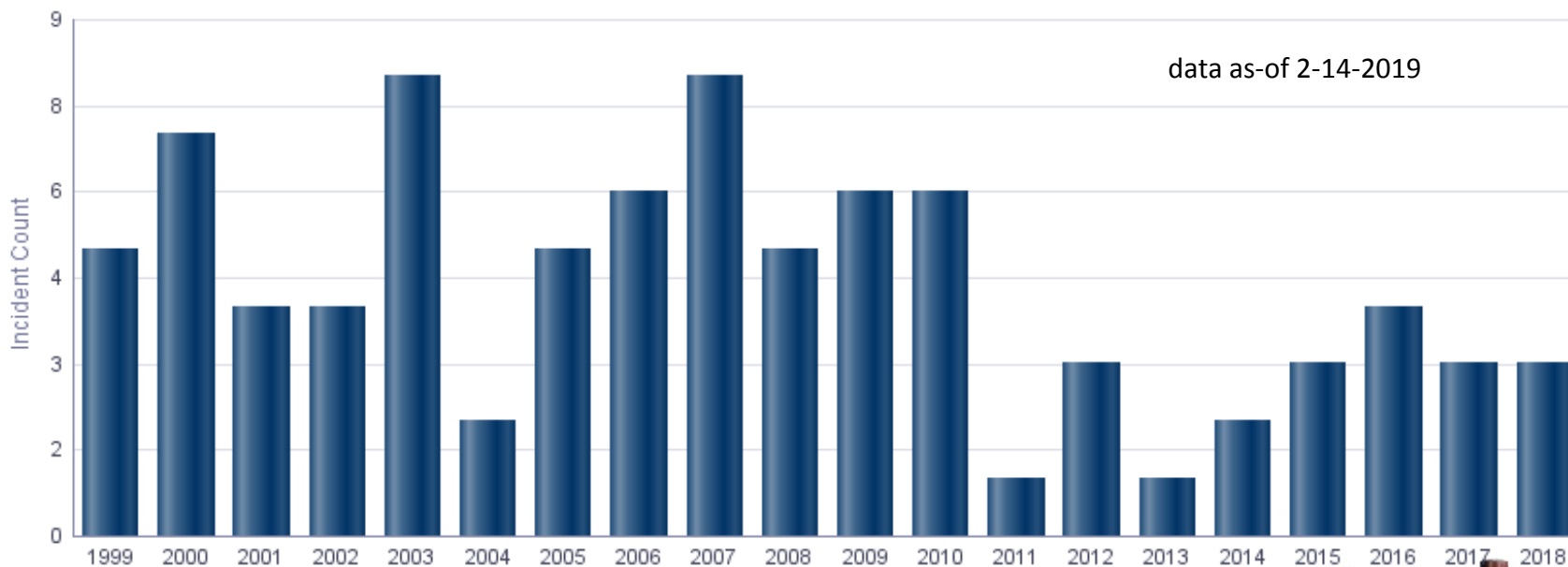


Gas Transmission Serious Incidents

All System Types
Increased in 2018

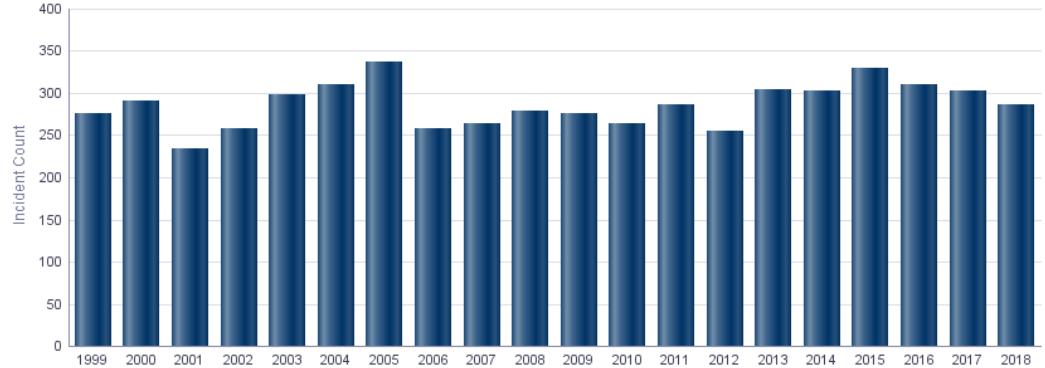


Gas Transmission
Unchanged in 2018

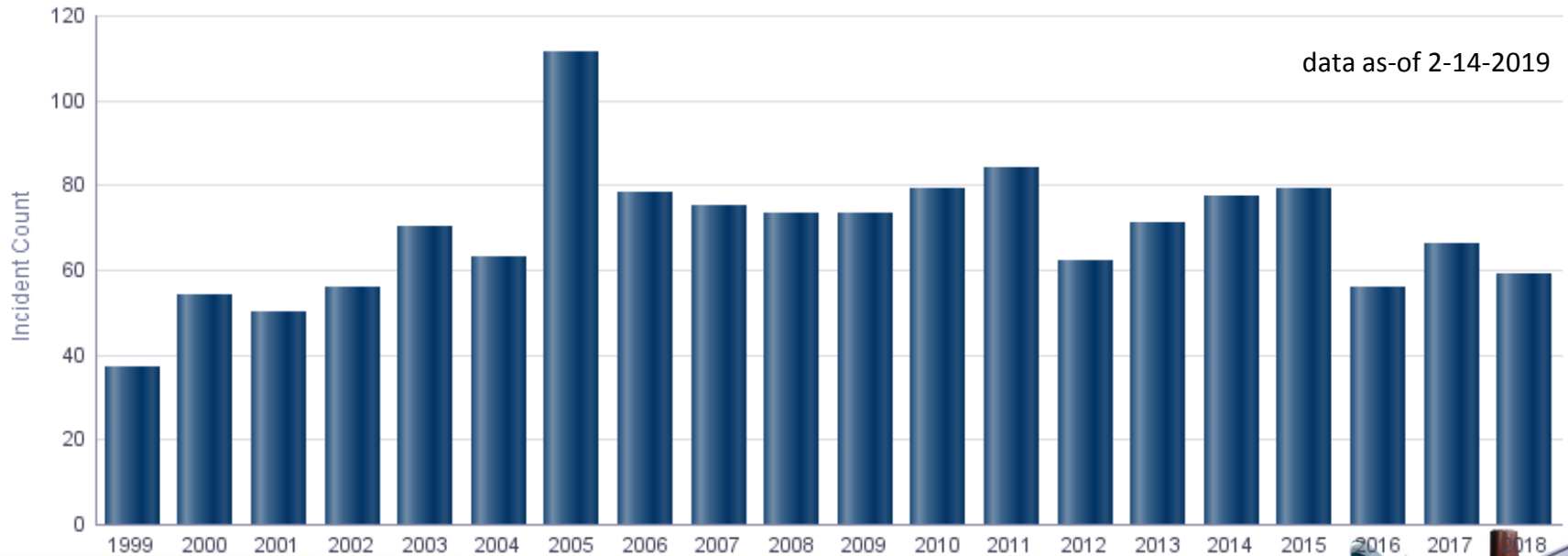


Gas Transmission Significant Incidents

All System Types
Decreased in 2018



Gas Transmission
Decreased in 2018



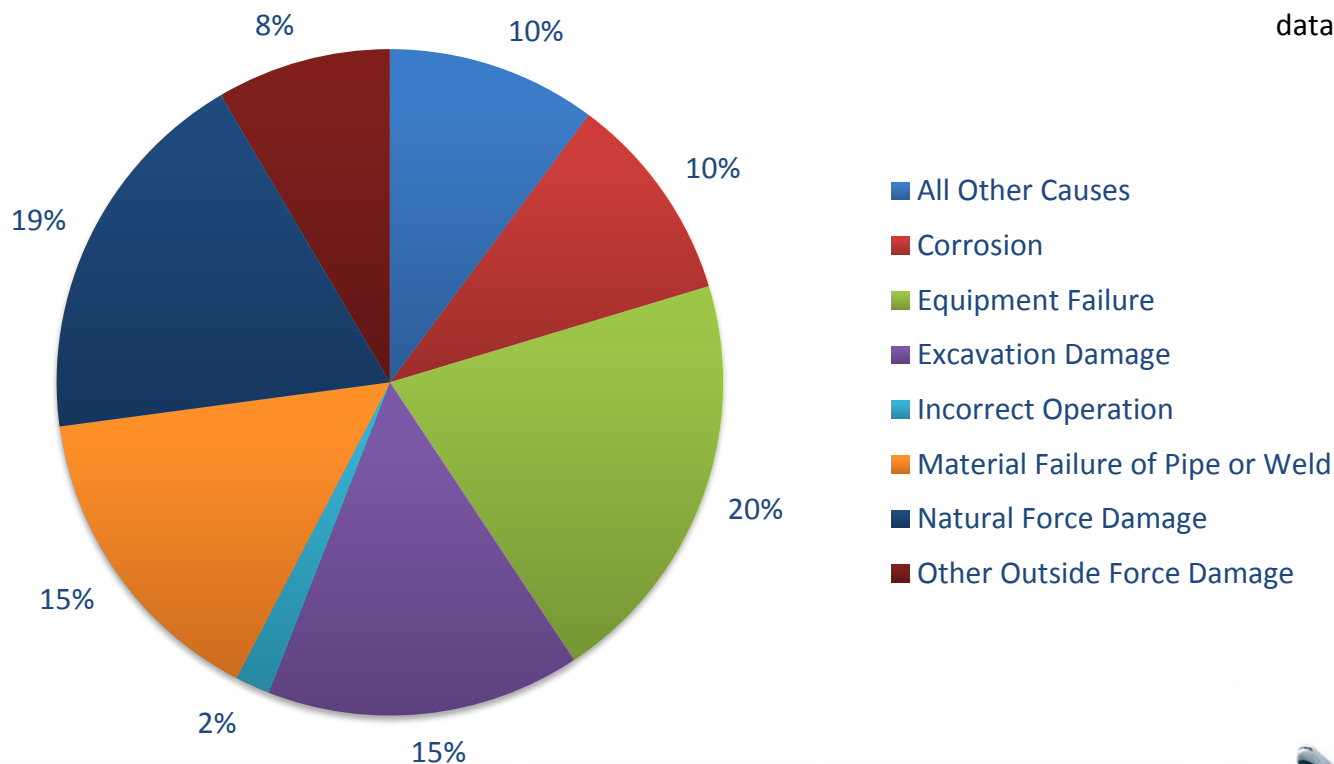
Gas Transmission Significant Incidents

CY 2018 Leading Causes:

Equipment Failure

Natural Force Damage

Material Failure of Pipe or Weld & Excavation Damage

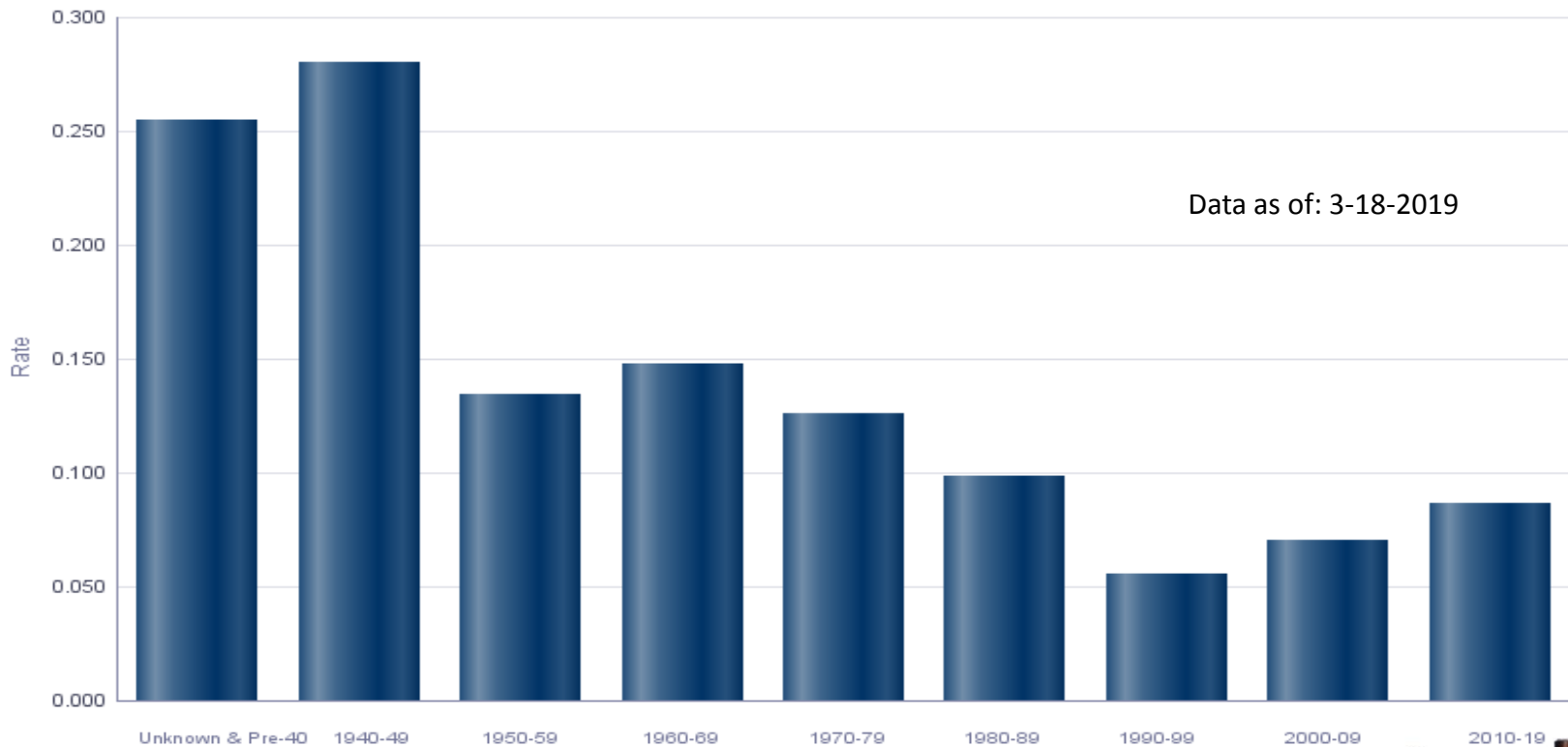


Gas Transmission Onshore Pipeline Significant Incident Rates per Decade 2005 - 2018 - Incidents per 1,000 Miles

“Unknown and Pre-1940” decade leading cause is Corrosion

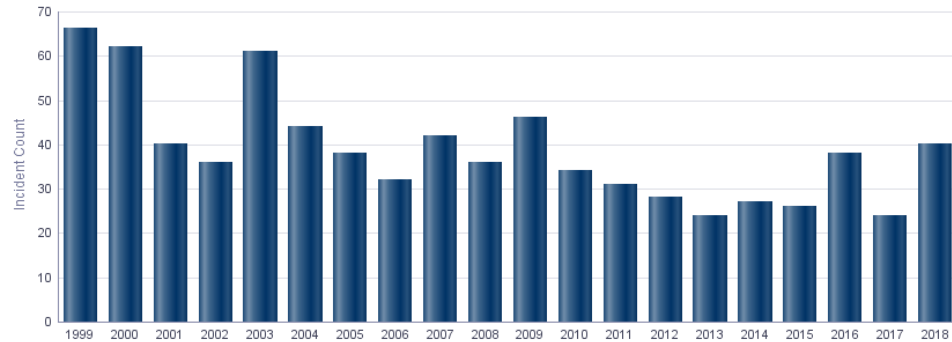
“1940s” decade leading cause is Material Failure of Pipe or Weld

“2010s” decade leading cause is Equipment Failure



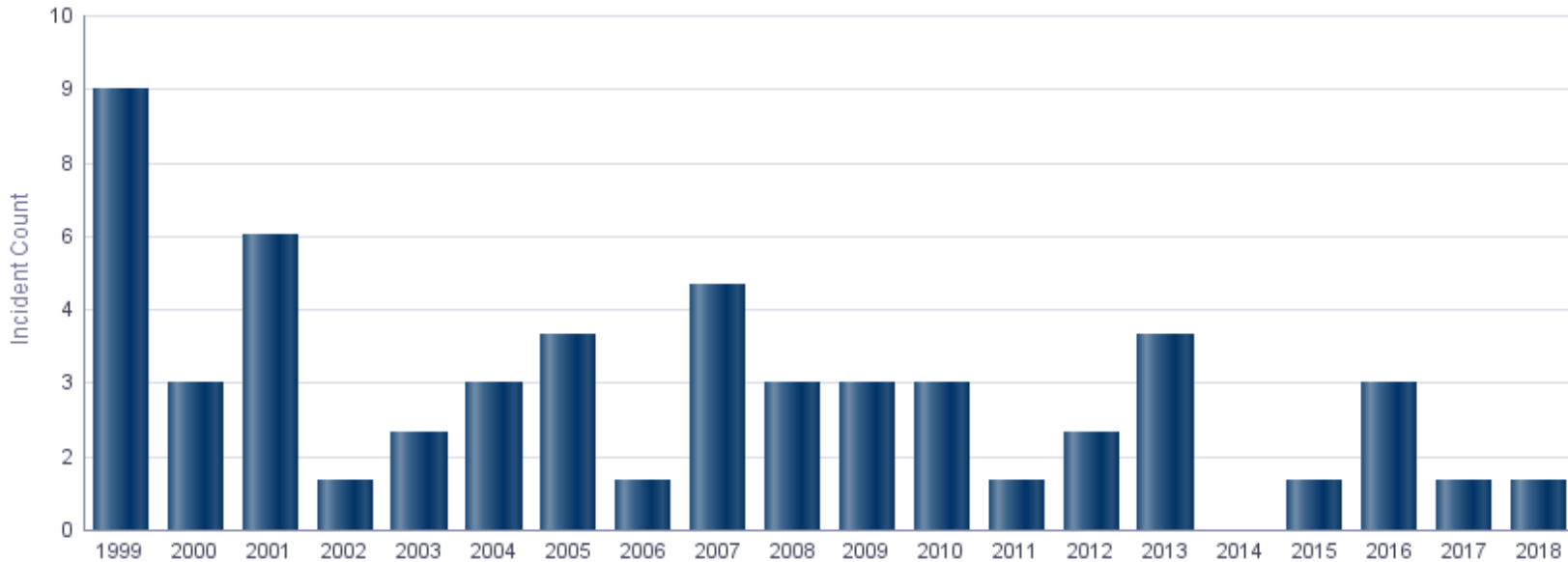
Hazardous Liquid Serious Incidents

All System Types
Increased in 2018



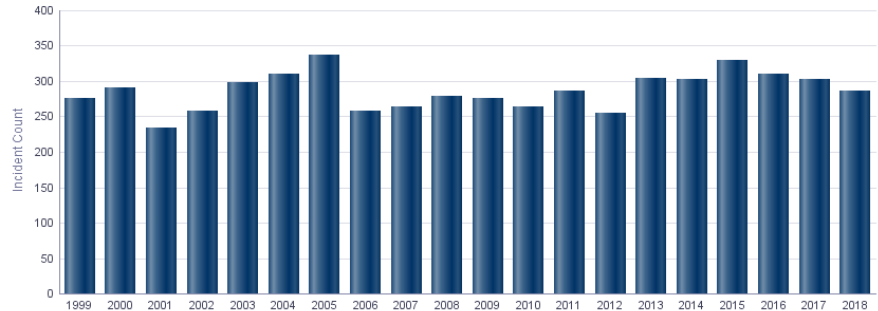
Hazardous Liquid
Unchanged in 2018

data as-of 2/14/2019



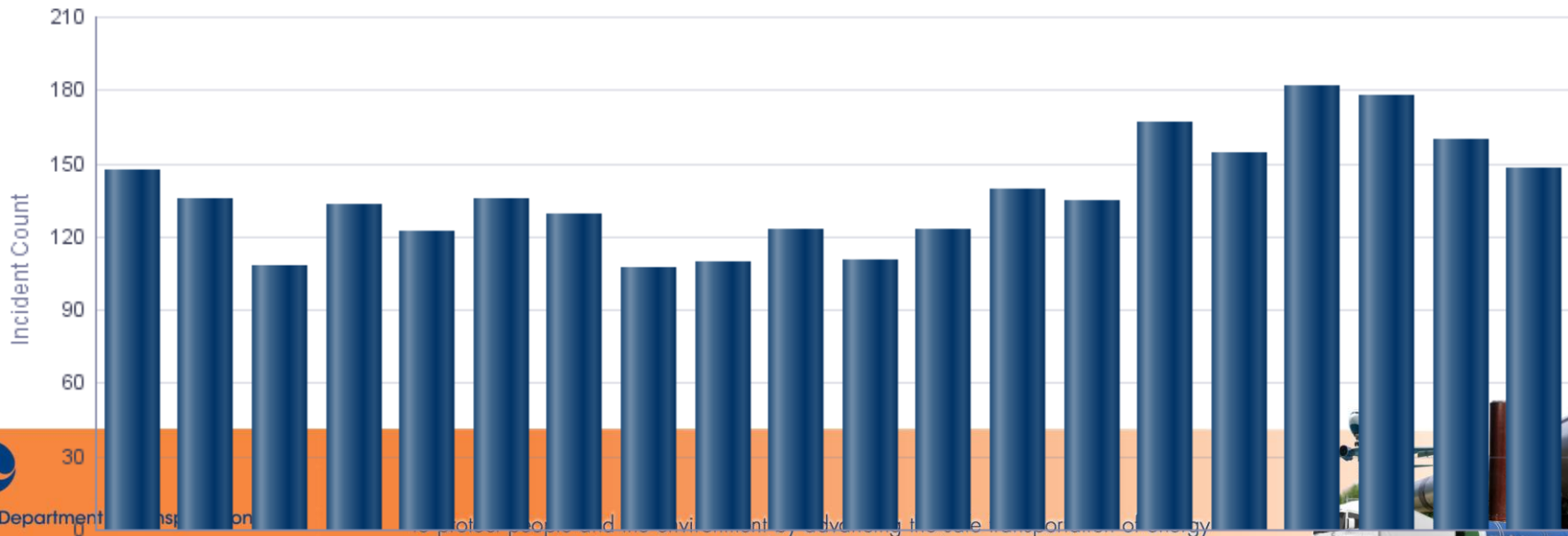
Hazardous Liquid Significant Incidents

All System Types
Decreased in 2018



Hazardous Liquid
Decreased in 2018

data as-of 2-14-2019



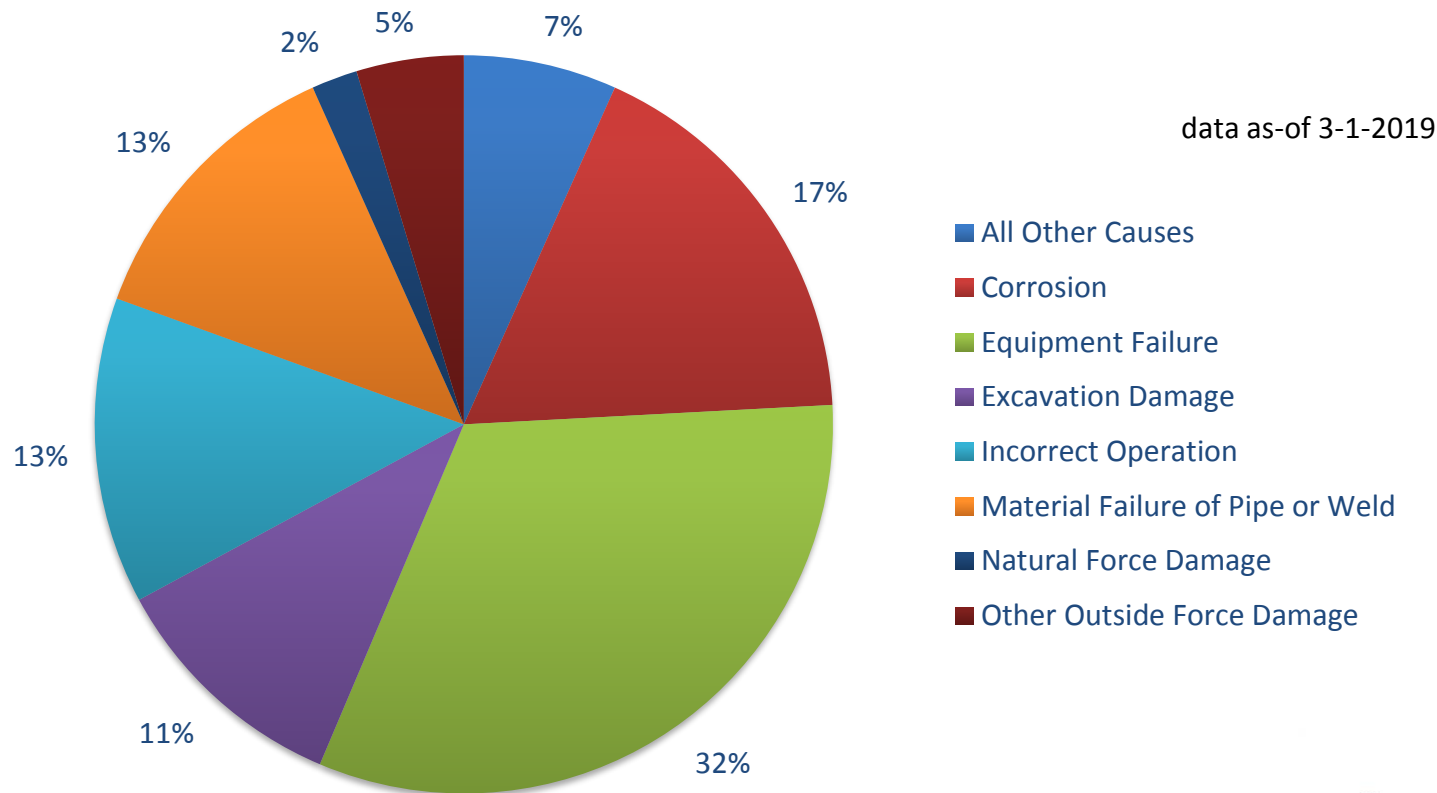
Hazardous Liquid Significant Incidents

CY 2018 Leading Causes:

Equipment Failure

Corrosion

Incorrect Operation & Material Failure of Pipe or Weld



Regulated Gas Gathering Significant Incidents – 2008-2017

CY 2008 to 2017 Leading Causes:

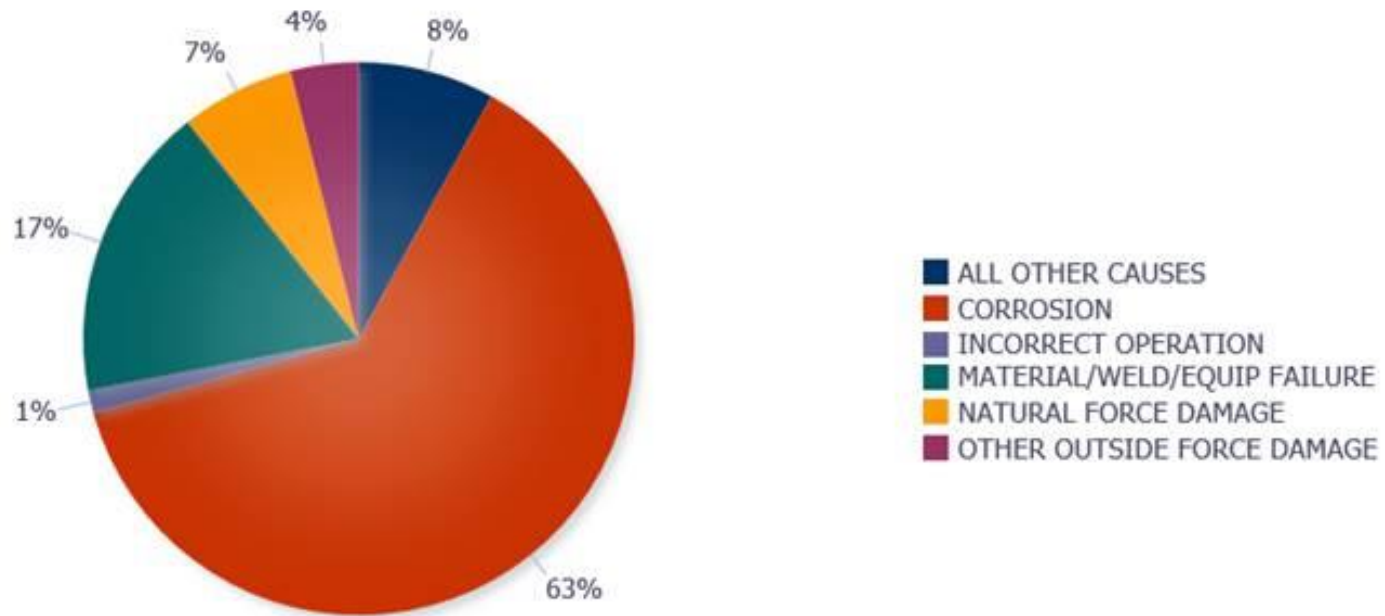
Corrosion - 63%

Material/Weld/Equipment Failure - 17%

All Other Causes - 8%

Significant Incident Cause Breakdown 10 Year Average (2008-2017)

System Type: GAS GATHERING State: (All Column Values) Offshore: (All Column Values)



Lessons Learned

- Operators need to know their systems well for successful risk management
- IMP is a good foundation that must be built upon
 - Safety Management Systems – API RP 1173
- Construction challenges remain.
- Theme - “What Gets Measured, Gets Done”



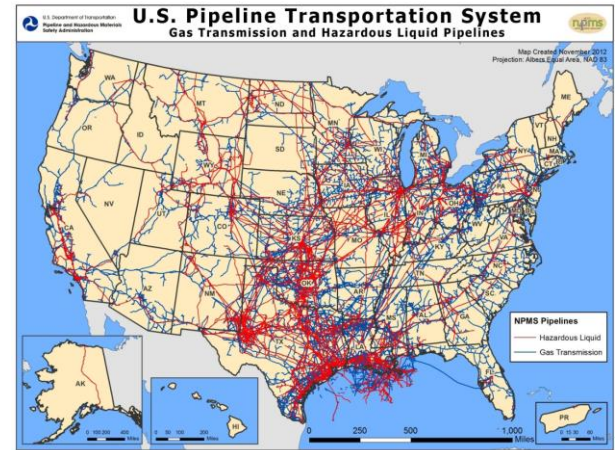
Pipeline Safety Research Development & Technology: Competitive Academic Agreement Program

CAAP



R&D Program Drivers

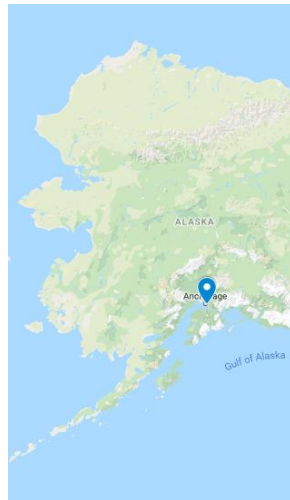
- Alignment with PHMSA mission & safety risk
- Congressional Mandates
- NTSB, GAO, & IG recommendations
- Support PHMSA basic research gaps
- Input from R&D Forum & Spur Innovation
- Technical Advisory Committees oversight



PHMSA's mission is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives.



- Arizona State University
- Colorado School of Mines
- Columbia University
- Georgia Institute of Technology
- Iowa State University
- Michigan State University
- North Dakota State University
- Ohio University
- Ohio State University
- Rutgers University
- Texas A&M Engineering Experiment Station
- University of Akron
- University of Alaska Anchorage
- University of Buffalo
- University of Colorado Boulder
- University of Colorado Denver
- University of Missouri Rolla
- University of Nebraska Lincoln
- University of North Dakota
- University of Tulsa
- University of Texas at Austin
- West Virginia University



CAAP 2013-2018:
 22 Universities
 42 Projects
 \$9.2M PHMSA /\$3M Cost Share

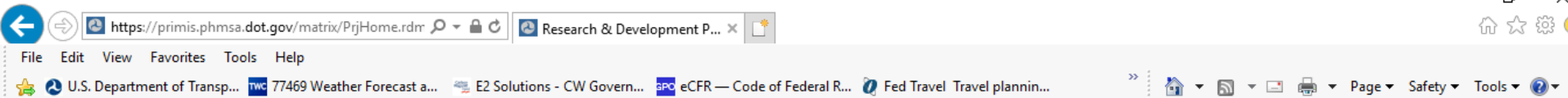


Monitoring Project Performance

- Technical Representatives will monitor the contractor's progress in completing project scope and milestone deliverables
- Project Modifications
- Quarterly Reporting
- Technical Representatives will monitor both federal and cost sharing on their project(s)



<https://primis.phmsa.dot.gov/matrix/>



Development of a Prediction Model for Pipeline Failure Probability Based on Learnings from Past Incidents and Pipeline Specific Data using Artificial Neural Network (ANN)

Main Objective

- To develop a knowledge based predictive model to assess pipeline failure through
- Learning about causes behind pipeline failure: Conducting root cause analysis of past incidents to identify those factors that have to potential to contribute to failure. The findings are to be specific to the extent that they can be applied into a predictive model.
 - Implementation of learning to predict failure: Utilizing the learnings about contributing factors behind pipeline failure to develop a predictive model based on artificial neural networks that monitors current existing conditions to determine dynamic failure probability of a pipeline

Public Abstract

On-site inspection, laboratory analysis and mechanical testing may to a certain extent provide information regarding likely failure possibility of a pipeline if exposed to a specific condition. In reality however, a range of diverse factors including particular environmental conditions, natural calamities, terrorist acts and even deficiencies in management's attempt to maintain the integrity can simultaneously influence pipeline operations and cause early failure. Influence of these numerous factors altogether are difficult to understand and predict and hence a deterministic prediction of failure based on laboratory findings and inspections can be misleading. Which factors can contribute to pipeline failure and to what extent they may contribute can be understood from root cause analysis of past incidents for better assessment and prediction of pipeline failures. Since a large variety of causes may arise from analysis of all past incidents, it is not possible to rely solely on experts to develop a model for pipeline failure that incorporates all the finding from the analyses of past incidents. For such cases, utilization of artificial neural network seems promising. The suitability of ANN for this purpose lies in its ability learn from past records to produce a predictive model, model complex non-linear behavior that may exist in any socio-technical system, recognize or classify patterns in behavior and interaction of various contributing factors, and tolerate noises and deal with large data. Although artificial neural network has been used in the past for prediction of pipeline conditions, none of the models considered contribution of human and organizational factors behind failures. Yet, most root cause analyses find such factors as causes behind incidents. Current proposal looks at integrating information about technical, operational, human and organizational factors that have contributed to past incidents with current pipeline specific conditions to develop a model that utilizes artificial neural network to predict the failure probability.

QUARTERLY STATUS REPORTS

1st Quarterly Report

 [PHMSA693JK31850011CAAPQUARTERLYREPORTY1Q1.PDF](#) (90,047 bytes) [\[VIEW\]](#) [\[DOWNLOAD/SAVE...\]](#)

2nd Quarterly Report

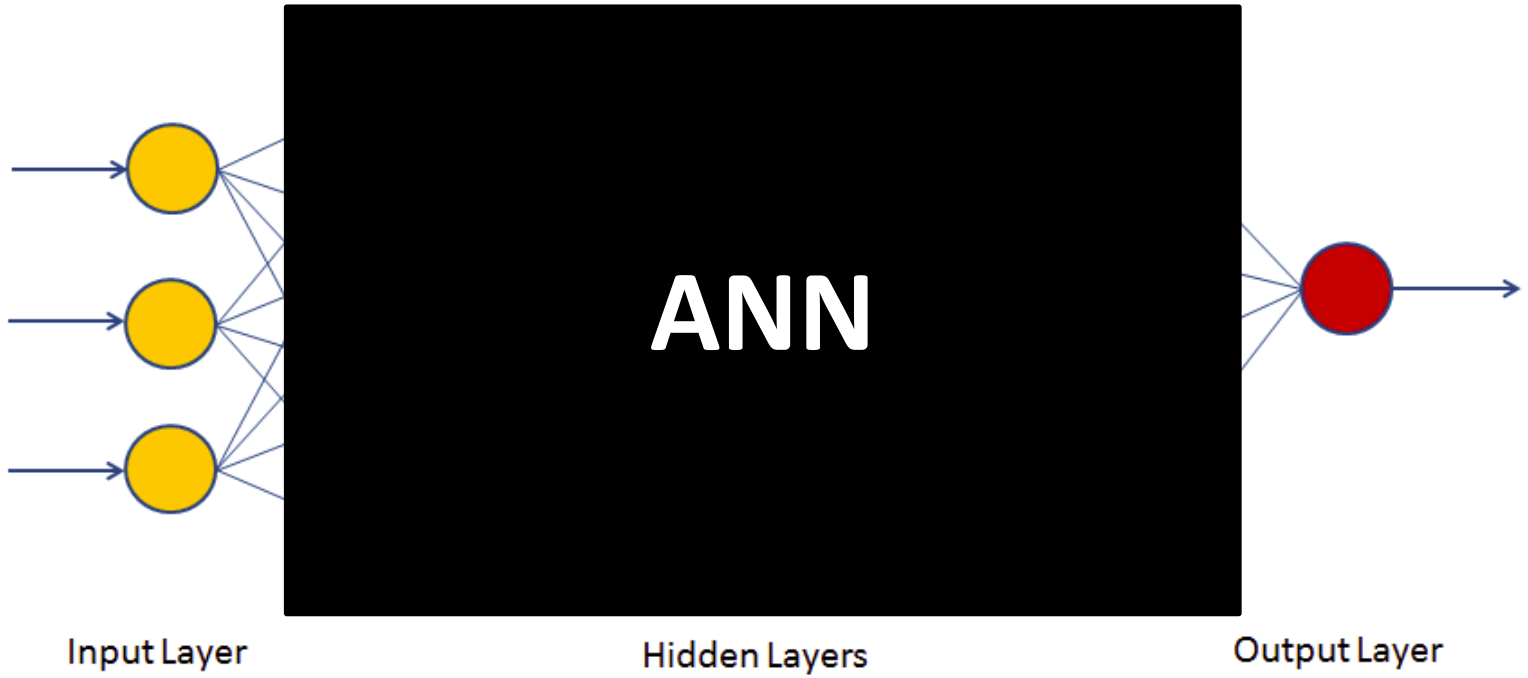
 [PHMSA693JK31850011CAAPQUARTERLYREPORTY1Q2.PDF](#) (99,140 bytes) [\[VIEW\]](#) [\[DOWNLOAD/SAVE...\]](#)

Fast Facts

<i>Research Award Recipient:</i>	Texas A&M Engineering Experiment Station 400 Harvey Mitchell Parkway South Suite 300 College Station, TX 77845-4375
<i>AOR:</i>	Joshua Arnold, joshua.arnold@dot.gov , 202-366-6085 Bill Lowry, Bill.Lowry@dot.gov , 713-272-2845
<i>Contract #:</i>	693JK31850011CAAP
<i>Project #:</i>	789
<i>Researcher Contact Info:</i>	Dr. James Holste 979-845-3384 j-holste@mail.che.tamu.edu
Downloads of Project Reporting	
<i>Since Jan 1, 2017</i> 35	
Financial and Status Data	
<i>Project Status:</i>	Active
<i>Start Fiscal Year:</i>	2018 (09/28/2018)
<i>End Fiscal Year:</i>	2021 (09/28/2021)
<i>PHMSA \$\$ Budgeted:</i>	\$300,000.00



Artificial Neural Networks (ANN)=Set of algorithms(mathematical structure) capable of recognizing patterns and representing complex processes



Risk-Based, Data Informed Inspections

-
337 -
7



Step 1 Data Analysis – At the National Level

Step 2 Risk Prioritized List of Systems

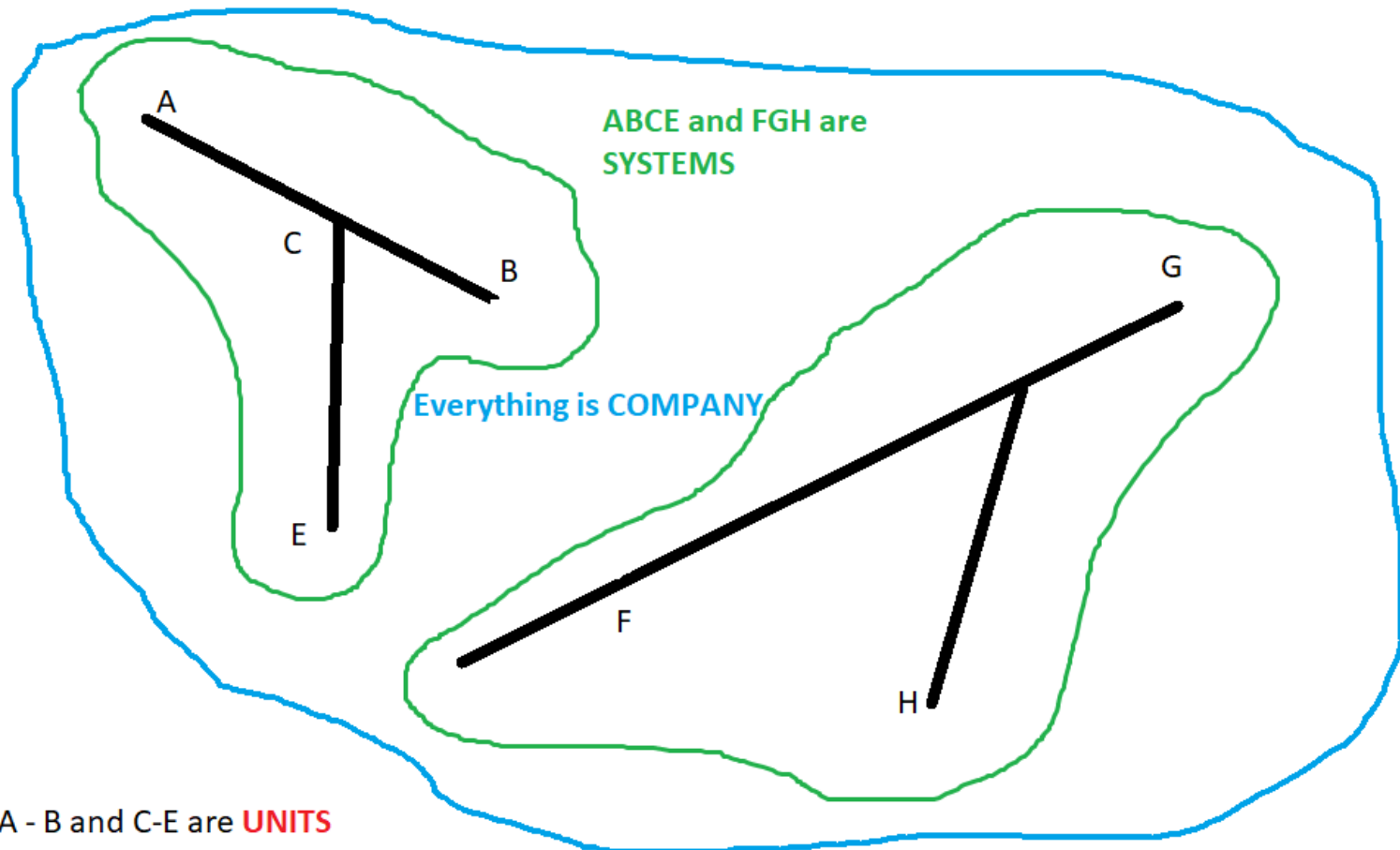
Step 3 Second Level Data Evaluation – At the System Level

Step 4 Tailored, Risk Informed Inspection Protocol



Data Analysis – National Level

Pipeline data is tracked at the **UNIT**, **SYSTEM** and **COMPANY** level.



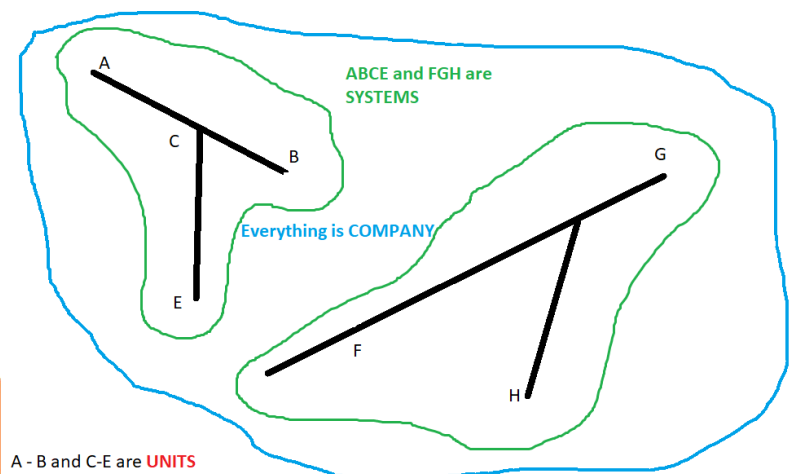
Data Analysis – National Level

- For all units in an inspection system, a unit risk score is generated based on known risk factors, i.e. bare steel, seam type, incident history, enforcement, etc.
- Consequence calculations take into commodity, proximity to high consequence areas like drinking water, population centers, and ecological areas, etc.



Data Analysis – National Level

- The inspection system risk score is the average of the risk score for the units within the inspection system.
- Each inspection system risk score is assigned to one of three risk tiers, each with a maximum time since last inspection (TSLI).
(3, 5 and 7 years)



Steps 3 and 4

- Steps 1 and 2 produce an annual risk ranked list of systems for inspection.
- An Inspection Team meets with the company to conduct a “Screening” session to make sure key data points have not changed.
- The Team then identifies the most risky areas for the system using data, experience and other factors.
- The Team creates a tailored inspection protocol, from over 2400 inspection questions, that will add an additional focus on risk areas, such as corrosion, cracking, operational controls, training, etc.



PHMSA Website Locations for Regulatory Status

Interpretations (Search by date or regulation)

<http://www.phmsa.dot.gov/pipeline/regs/interps>

Special Permits and State Waivers

<http://www.phmsa.dot.gov/pipeline/regs/special-permits>

Rulemakings (tabular with links to detail)

<http://www.phmsa.dot.gov/pipeline/regs/rulemaking>

Advisory Bulletins (tabular with links to detail)

<http://www.phmsa.dot.gov/pipeline/regs/advisory-bulletin>

The Significant Rulemakings Report

<https://www.transportation.gov/regulations/report-on-significant-rulemakings>



Additional PHMSA Website Locations

Pipeline Technical Resources

<https://primis.phmsa.dot.gov/ptr.htm>

Meetings

<http://primis.phmsa.dot.gov/meetings/>

Electronic Reading Room

<http://www.phmsa.dot.gov/foia/e-reading-room>

Stakeholder Communications

<http://primis.phmsa.dot.gov/comm/>

PSA 2011 Reports and Studies

<https://www.phmsa.dot.gov/pipeline/psa/related-reports-and-studies>

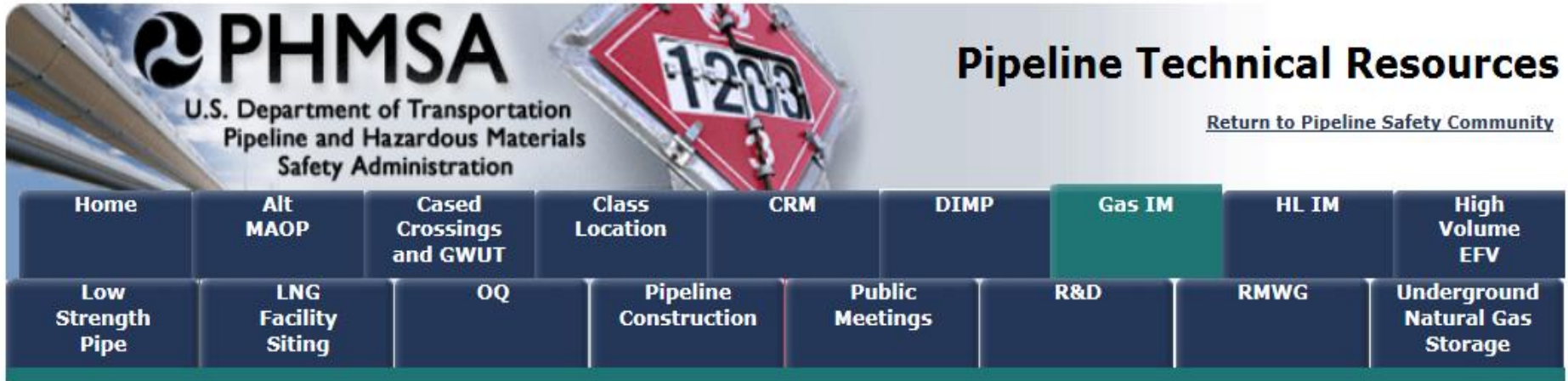


Additional PHMSA Websites– Pipeline Technical Resources

<https://primis.phmsa.dot.gov/ptr.htm>

- Alternative MAOP
- Cased Crossings & Guided Wave Ultrasonics (GWUT)
- Class Location Special Permits
- Control Room Management (CRM)
- Gas Distribution Integrity Management Program (DIMP)
- Gas Transmission Integrity Management (GT IM)
- Hazardous Liquid Integrity Management (HL IM)
- High Volume Excess Flow Valves (EFV)
- Low Strength Pipe
- Operator Qualification (OQ)
- Pipeline Construction
- Research & Development (R&D)
- Public Meetings
- Regulations & Interpretations





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Pipeline and Hazardous Materials
Safety Administration

Pipeline Technical Resources

[Return to Pipeline Safety Community](#)

Home	Alt MAOP	Cased Crossings and GWUT	Class Location	CRM	DIMP	Gas IM	HL IM	High Volume EFV
Low Strength Pipe	LNG Facility Siting	OQ	Pipeline Construction	Public Meetings	R&D	RMWG	Underground Natural Gas Storage	

Rectangular Strip

Gas Transmission Integrity Management

Gas IM Menu

- Home
- Key Documents
- Fact Sheet
- FAQs
- Inspection Protocols
- Performance Measures
- Flowchart

This site is administered by the Pipeline and Hazardous Materials Safety Administration (PHMSA). It provides information concerning the Gas Transmission Integrity Management Rule (49 CFR Part 192, Subpart O), commonly referred to as the "Gas IM Rule." The Gas IM Rule specifies how pipeline operators must identify, prioritize, assess, evaluate, repair and validate the integrity of gas transmission pipelines that could, in the event of a leak or failure, affect High Consequence Areas (HCAs) within the United States. HCAs include certain populated and occupied areas.

For an overview of the progress being made under the Gas IM Rule, please see our [Performance Measures](#) page. There you will find graphs and charts, which depict progress and other aspects of rule implementation. You will



Thank you.

William (Bill) Lowry, PE
Community Liaison

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