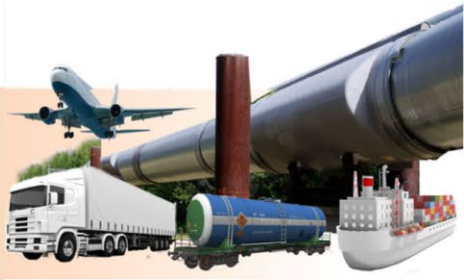
Pipeline and Hazardous Materials Safety Administration (PHMSA)

Office of Pipeline Safety (OPS)

Accident Investigation Division (AID)

February 6, 2024

Nebraska State Fire Marshal Pipeline Safety Seminar



Agenda

- Accident Investigation Division
- Reporting Incidents
- Nebraska State of the State
- Case Studies
- Trends & Insights from AID

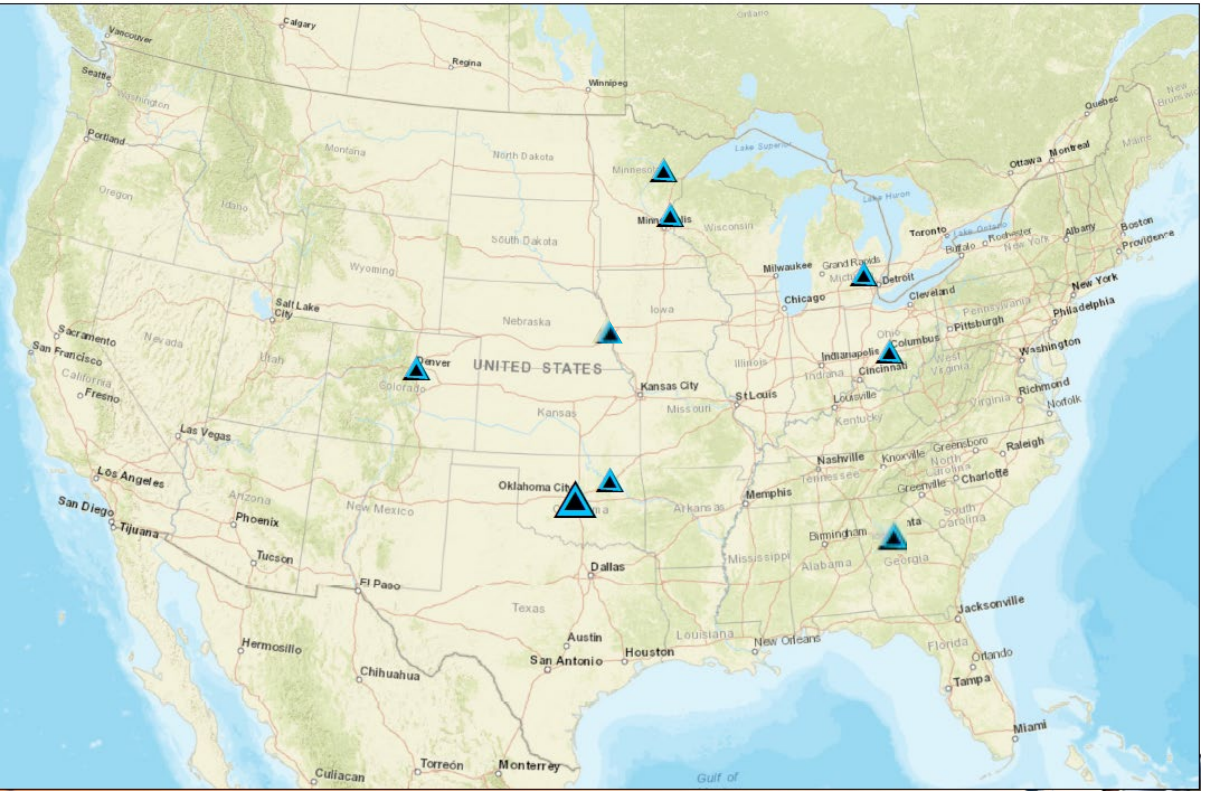
Accident Investigation Division

Accident Investigation Division

AID was established on April 1, 2017

- Director, Chris Ruhl
- Operations Supervisor, Ky Nichols
- Investigators:
  - Brian Pierzina (MN)
  - Darren Lemmerman (MN)
  - Gery Bauman (OH)
  - Curtis Huff (OK)
  - Wesley Mathews (OK)
  - Alvaro Rodriguez (CO)
  - Heather David (MI)
  - Timothy Disher (NE)
  - Besson Mathew (GA)
  - Jacob Jorgenson (MN)
  - Marisa Skillman (MI)
- Data Analyst, Meg O'Connor
- Administrative Assistant, Lisa Hollingshead

Accident Investigation Division



Chris Ruhl
Director

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Sr. Investigator

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Timothy Disher
Investigator

Marisa Skillman
Investigator

What does AID do?

- Review, Evaluate, and Circulate NRC Notifications
- Manage Investigation from Initial NRC Notification through Cause Determination
- Conduct Onsite Accident Investigations: Support NTSB and State Investigations
- Oversee Operator 30-Day Accident/Incident Reports
- Analyze Data to Identify Emerging Trends
- Capture and Share Lessons Learned (SAFE Bulletins, State Conferences, etc.)

When does AID Deploy?

- A release of product and one or more of the following:
  - Fatality
  - Injury
  - Hazardous liquid spill > 500 barrels or spill reaches water
  - Major transportation impact - highway, airport, rail
  - Major supply impact
  - Pipeline system/operator of interest
  - Toxic release – ammonia, CO_2
  - NTSB deploys
  - Politically sensitive/high media interest
  - At a State partner's request

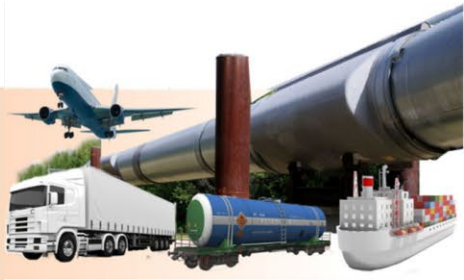
NPIC Duty and *High-Consequence Incidents

- Important to get timely responses and updates
  - Courtesy phone calls may also be made to state duty officer or program manager
- Distribution of known information
  - States, Regions, NTSB and PHMSA Executive Team
- State plays an important role in future updates (scheduling and content)

NPIC Hotline (888) 719-9033

PHMSAAID@dot.gov

*explosions, deaths, injuries, environment impact



Reporting Incidents

PHMSA Reporting Requirements

- PHMSA has NRC reporting requirements for pipeline systems
  - Initial (within earliest practical moment following discovery but no later than 1 hour

- Gas
- An event involving a release of gas
  - A death, or personal injury necessitating in-patient hospitalization
  - Greater than $139,700 estimated property damage
  - Unintentional estimated gas loss of 3 million cubic feet or more
  - An event that results in an emergency shutdown of an LNG facility or natural gas storage facility
  - An event that is characterized as significant by operator

- Hazardous Liquids
- An event involving the release of a liquid
  - A death, or personal injury necessitating in-patient hospitalization
  - Incident involved a fire or explosion
  - Greater than $50,000 property damage including the cost of the cleanup, value of product
  - Resulted in pollution of any stream, river, lake, reservoir or similar body of water
  - An event that is characterized as significant by operator

- 48-hour
  - Must provide an update to confirm/revise initial information reported.

Investigation of failures 192.617, 195.402(c)

Significant changes effective 10/5/22

Each operator shall establish procedures for analyzing accidents and failures, including the selection of samples of the failed facility or equipment for laboratory examination, where appropriate, for the purpose of determining the causes of the failure and minimizing the possibility of a recurrence.

Before

Investigation of failures and incidents.

(a) *Post-failure and incident procedures.* Each operator must establish and follow procedures for investigating and analyzing failures and incidents as defined in § 191.3, including sending the failed pipe, component, or equipment for laboratory testing or examination, where appropriate, for the purpose of determining the causes and contributing factor(s) of the failure or incident and minimizing the possibility of a recurrence.

(b) *Post-failure and incident lessons learned.* Each operator must develop, implement, and incorporate lessons learned from a post-failure or incident review into its written procedures, including personnel training and qualification programs, and design, construction, testing, maintenance, operations, and emergency procedure manuals and specifications.

(c) *Analysis of rupture and valve shut-offs.* If an incident on an onshore gas transmission pipeline or a Type A gathering pipeline involves the closure of a rupture-mitigation valve (RMV), as defined in § 192.3, or the closure of alternative equivalent technology, the operator of the pipeline must also conduct a post-incident analysis of all of the factors that may have impacted the release volume and the consequences of the incident and identify and implement operations and maintenance measures to prevent or minimize the consequences of a future incident. The requirements of this paragraph (c) are not applicable to distribution pipelines or Types B and C gas gathering pipelines. The analysis must include all relevant factors impacting the release volume and consequences, including, but not limited to, the following:

(1) Detection, identification, operational response, system shut-off, and emergency response communications, based on the type and volume of the incident;

(2) Appropriateness and effectiveness of procedures and pipeline systems, including supervisory control and data acquisition (SCADA), communications, valve shut-off, and operator personnel;

(3) Actual response time from identifying a rupture following a notification of potential rupture, as defined at § 192.3, to initiation of mitigative actions and isolation of the pipeline segment, and the appropriateness and effectiveness of the mitigative actions taken;

(4) Location and timeliness of actuation of RMVs or alternative equivalent technologies; and

(5) All other factors the operator deems appropriate.

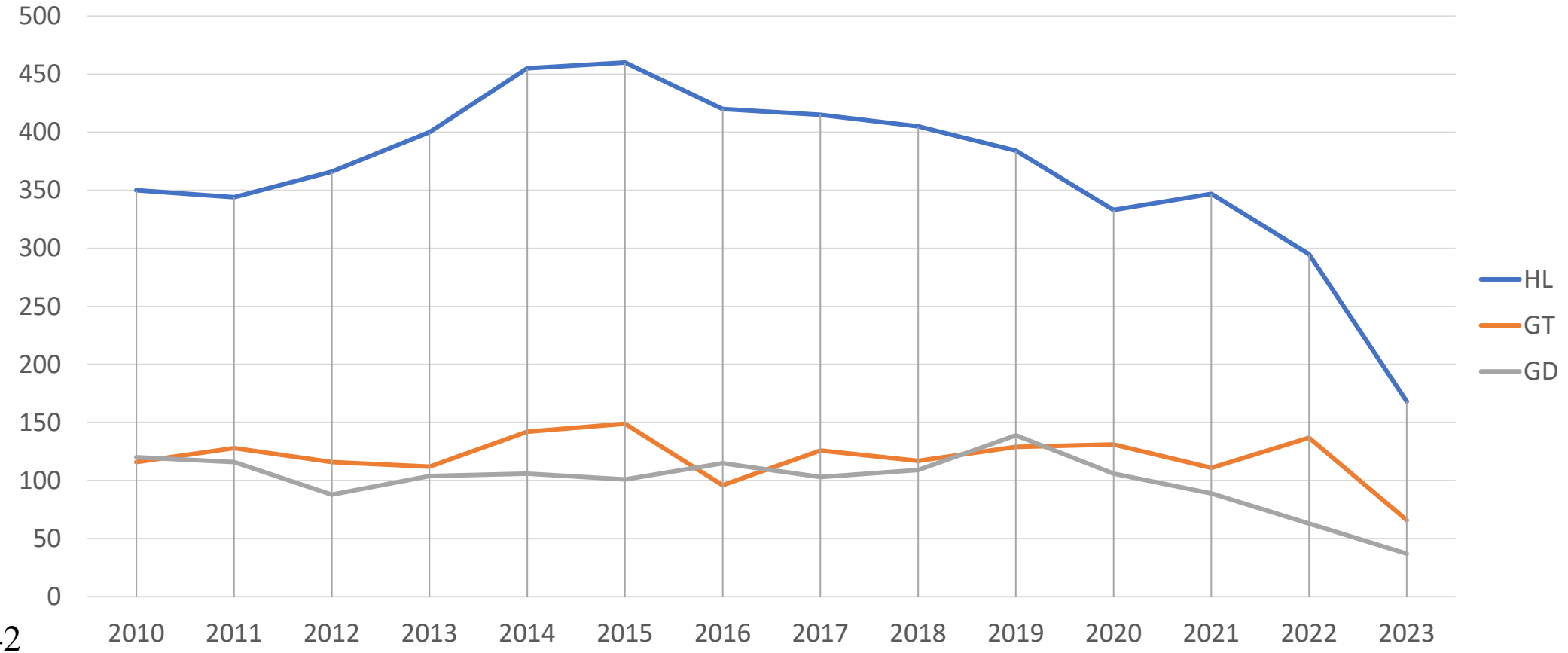
(d) *Rupture post-failure and incident summary.* If a failure or incident on an onshore gas transmission pipeline or a Type A gathering pipeline involves the identification of a rupture following a notification of potential rupture, or the closure of an RMV (as those terms are defined in § 192.3), or the closure of an alternative equivalent technology, the operator of the pipeline must complete a summary of the post-failure or incident review required by paragraph (c) of this section within 90 days of the incident, and while the investigation is pending, conduct quarterly status reviews until the investigation is complete and a final post-incident summary is prepared. The final post-failure or incident summary, and all other reviews and analyses produced under the requirements of this section, must be reviewed, dated, and signed by the operator's appropriate senior executive officer. The final post-failure or incident summary, all investigation and analysis documents used to prepare it, and records of lessons learned must be kept for the useful life of the pipeline. The requirements of this paragraph (d) are not applicable to distribution pipelines or Types B and C gas gathering pipelines.

After

Investigation of failures 192.617, 195.402(c)

- Post-failure and incident procedures
  - Must establish and follow procedures for investigating failures and incidents
    - Includes sending failed specimen to lab to determine cause and contributing factors
- Post-failure and incident lesson learned
  - Must develop, implement and incorporate lessons learned
- Analysis of rupture and valve shutoffs
  - When incidents cause the closure of RMV, operator must conduct a post incident analysis
- Rupture post-failure and incident summary
  - Required within 90 days of incident with quarterly status reviews until complete

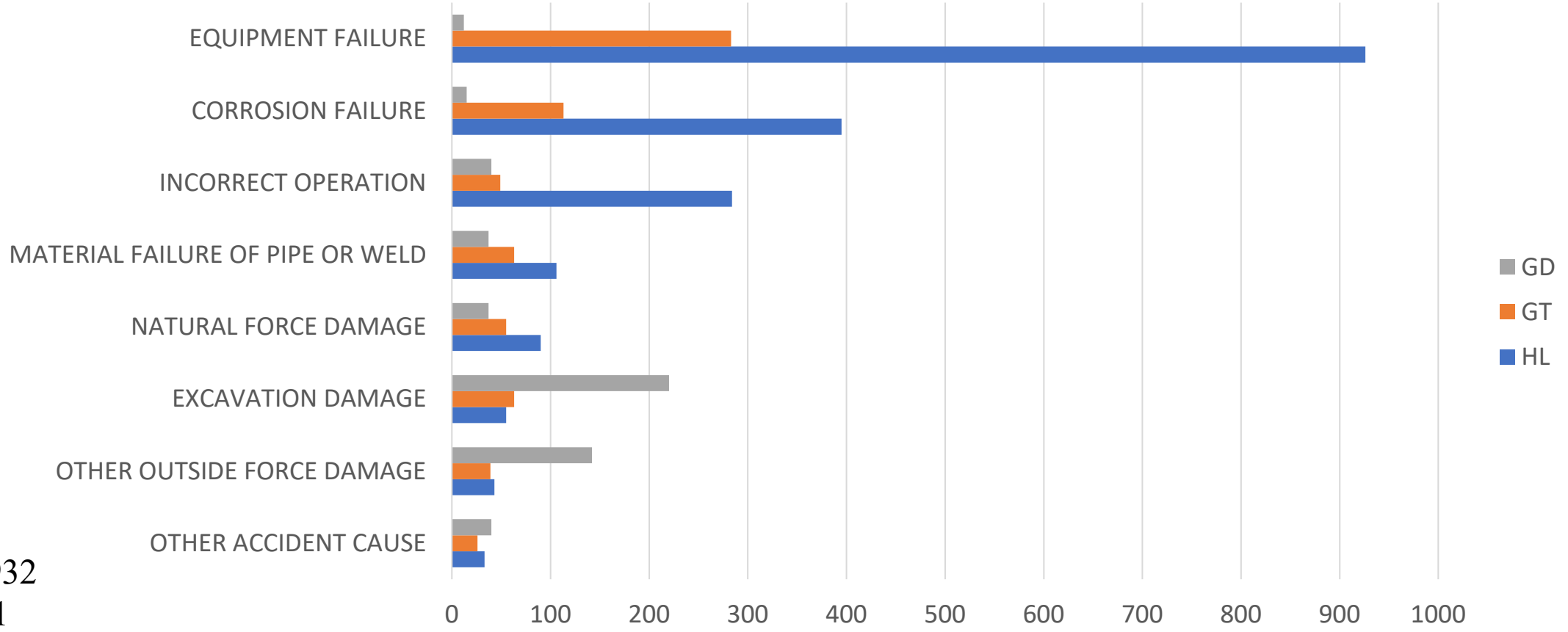
Number of Reportable Accidents by Year (2010 – August 2023)



Qty

HL: 5,142
GT: 1,676
GD: 1,396

Number of Reportable Accidents by Cause (2018 – August 2023)



Qty

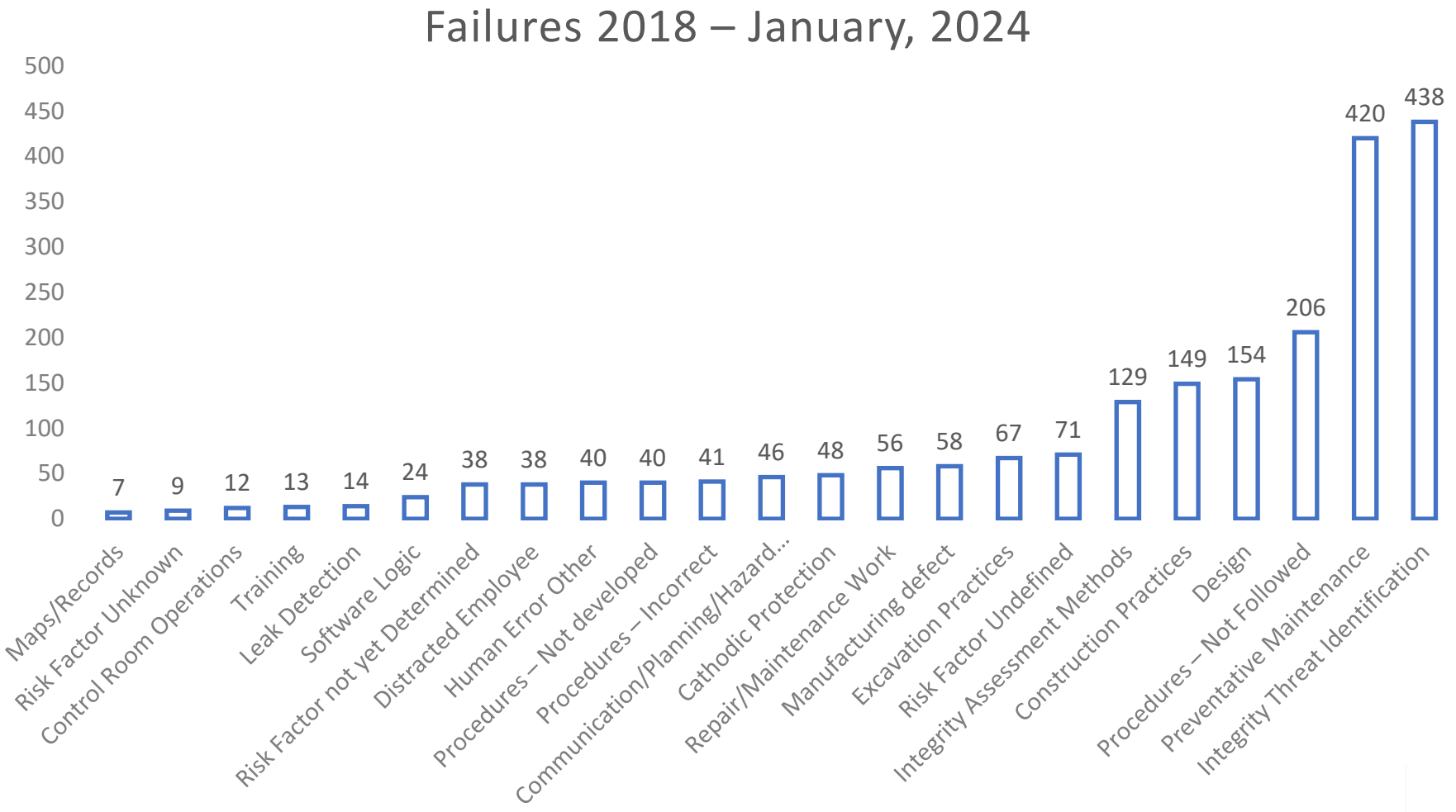
HL: 1,932
GT: 691
GD: 543

Risk Factors

Cathodic Protection	Leak Detection
Communication/Hazard Assessment	Manufacturing Defect
Construction	Maps/Records
Control Room	Preventative Maintenance
Design	Training
Distracted Employee	Repair/Maintenance Work
Human Error	Software Logic
Integrity Assessment Methods	Procedures –Incorrect, Not Developed, or Not Followed
Integrity Threat Identification	Risk Factor –Undefined, Unknown, or Not Yet Determined

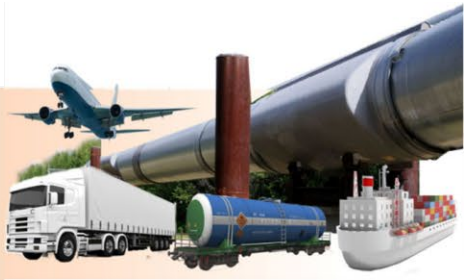
*Developed and implemented by AID starting with 2018 data – It can only be accessed through PHMSA WMS

Risk Factors

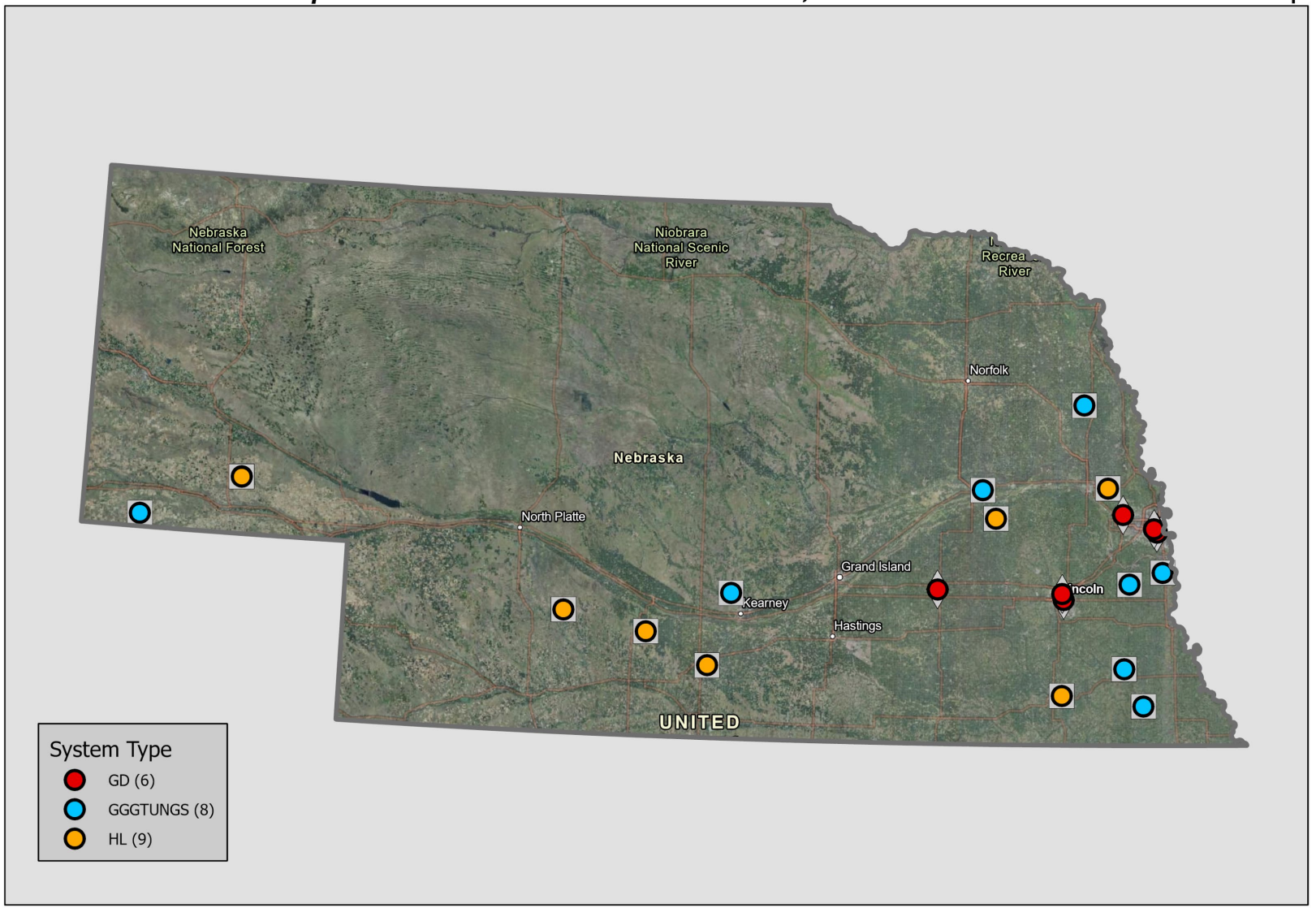


Nebraska State of the State

(Data from January 1, 2018 to January 1, 2024)

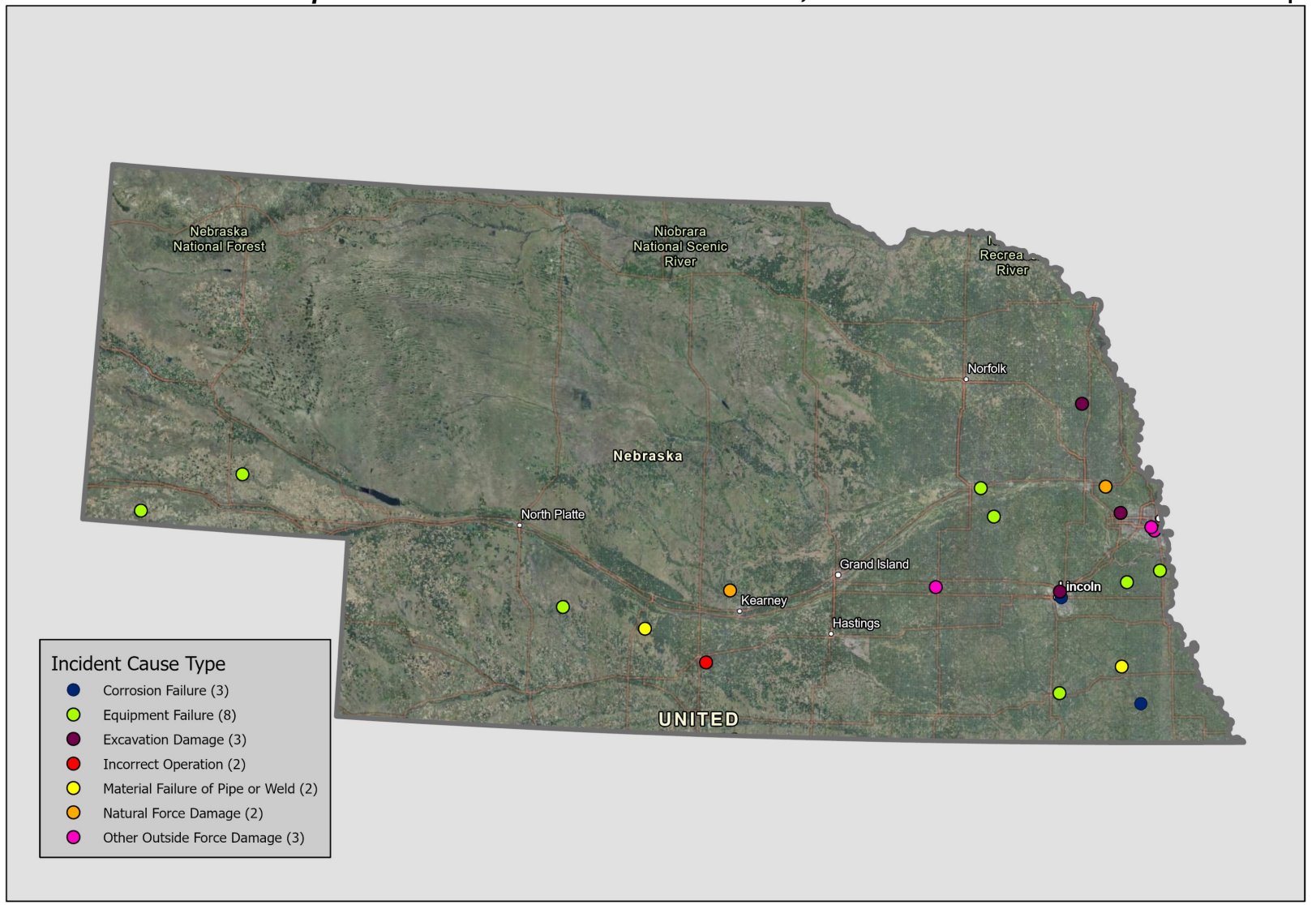


Pipeline Failure Locations in Nebraska, 2018 - Present



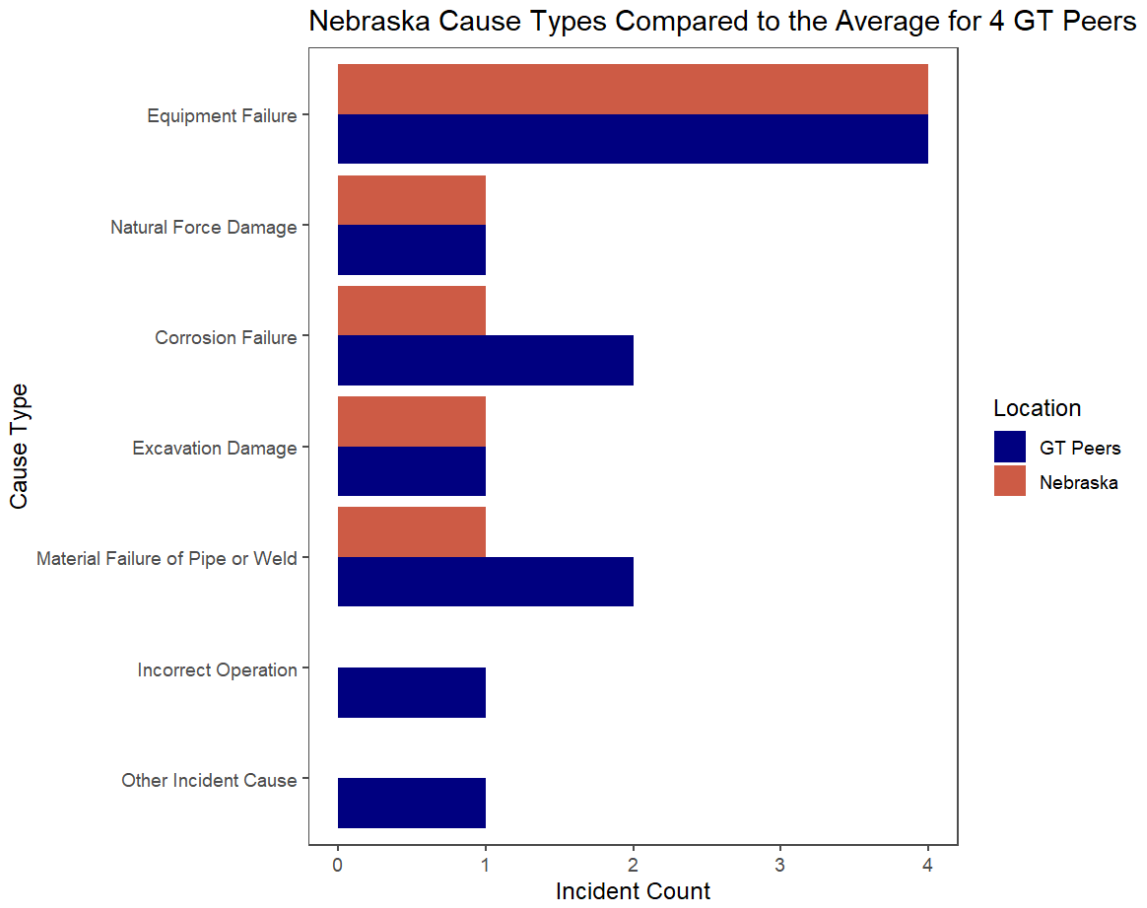
*Data from January 2018 to January 2024

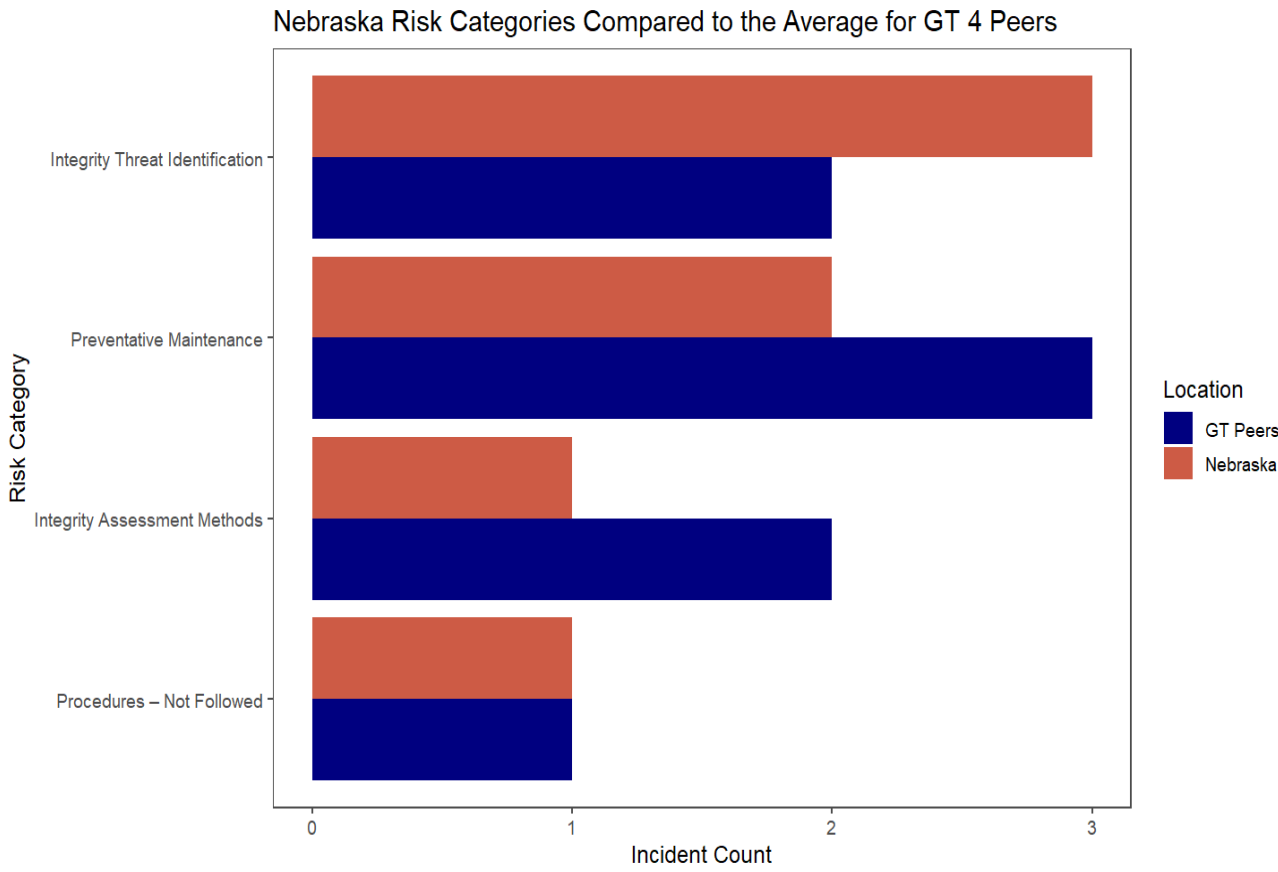
Pipeline Failure Locations in Nebraska, 2018 - Present



*Data from January 2018 to January 2024

Nebraska Incidents - GT





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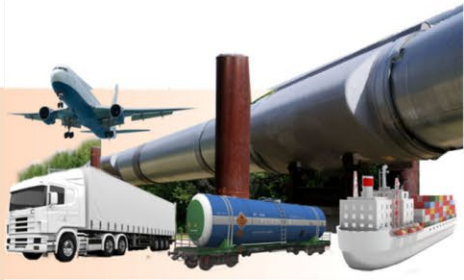
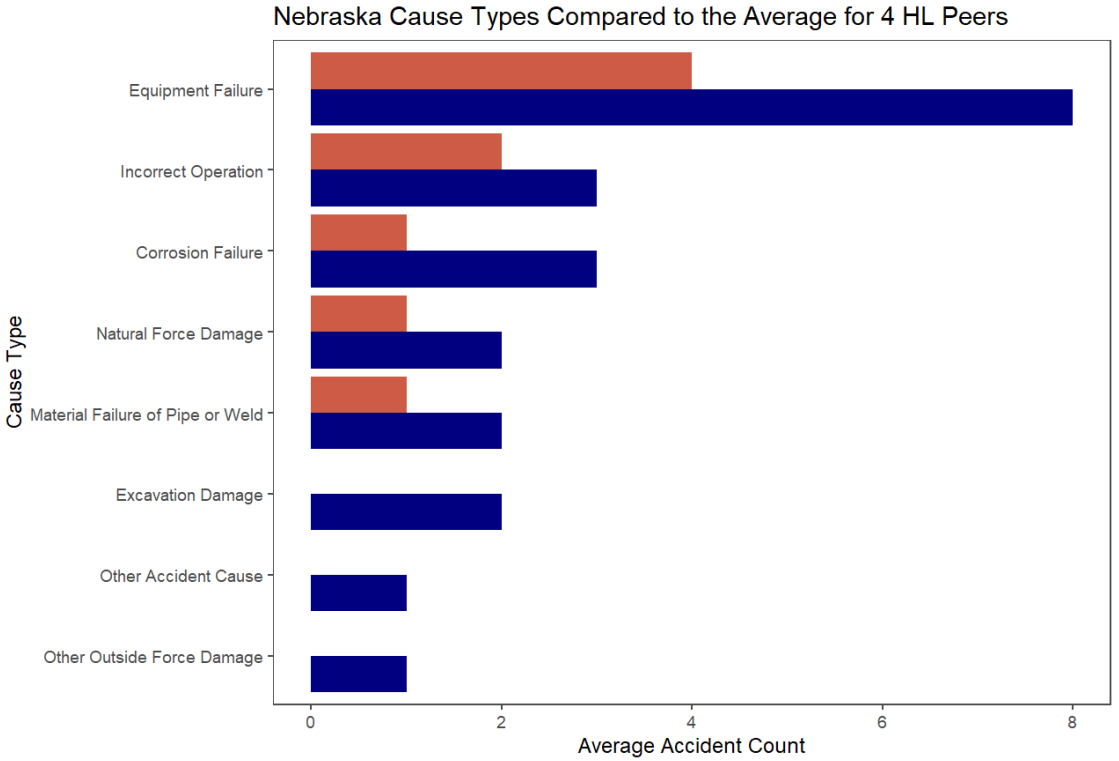
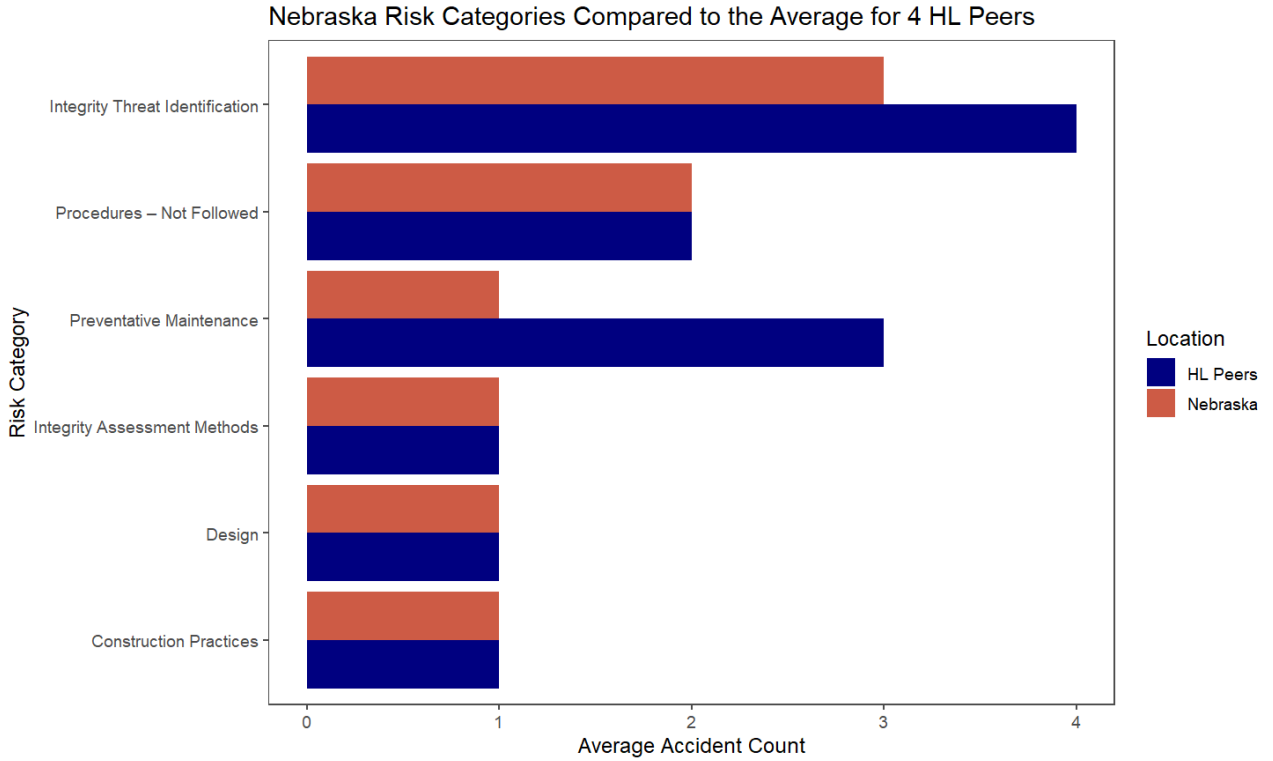


Nebraska Incidents - HL

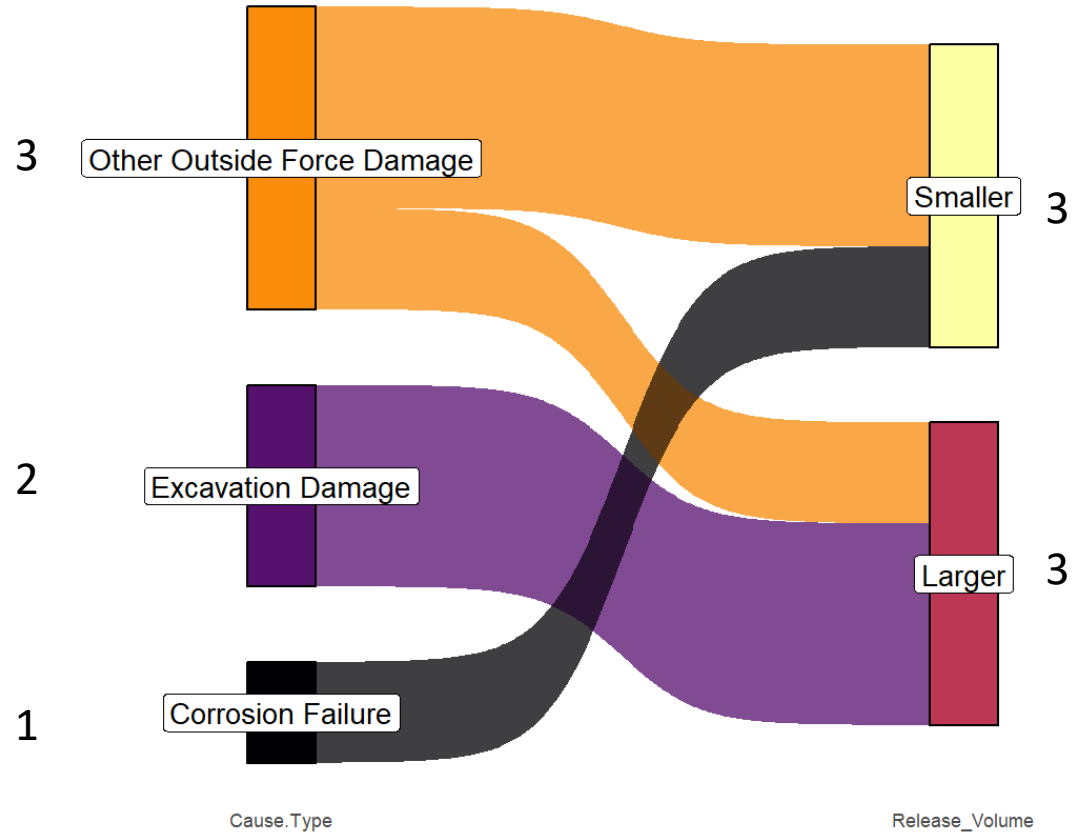




*Data from January 2018 to January 2024

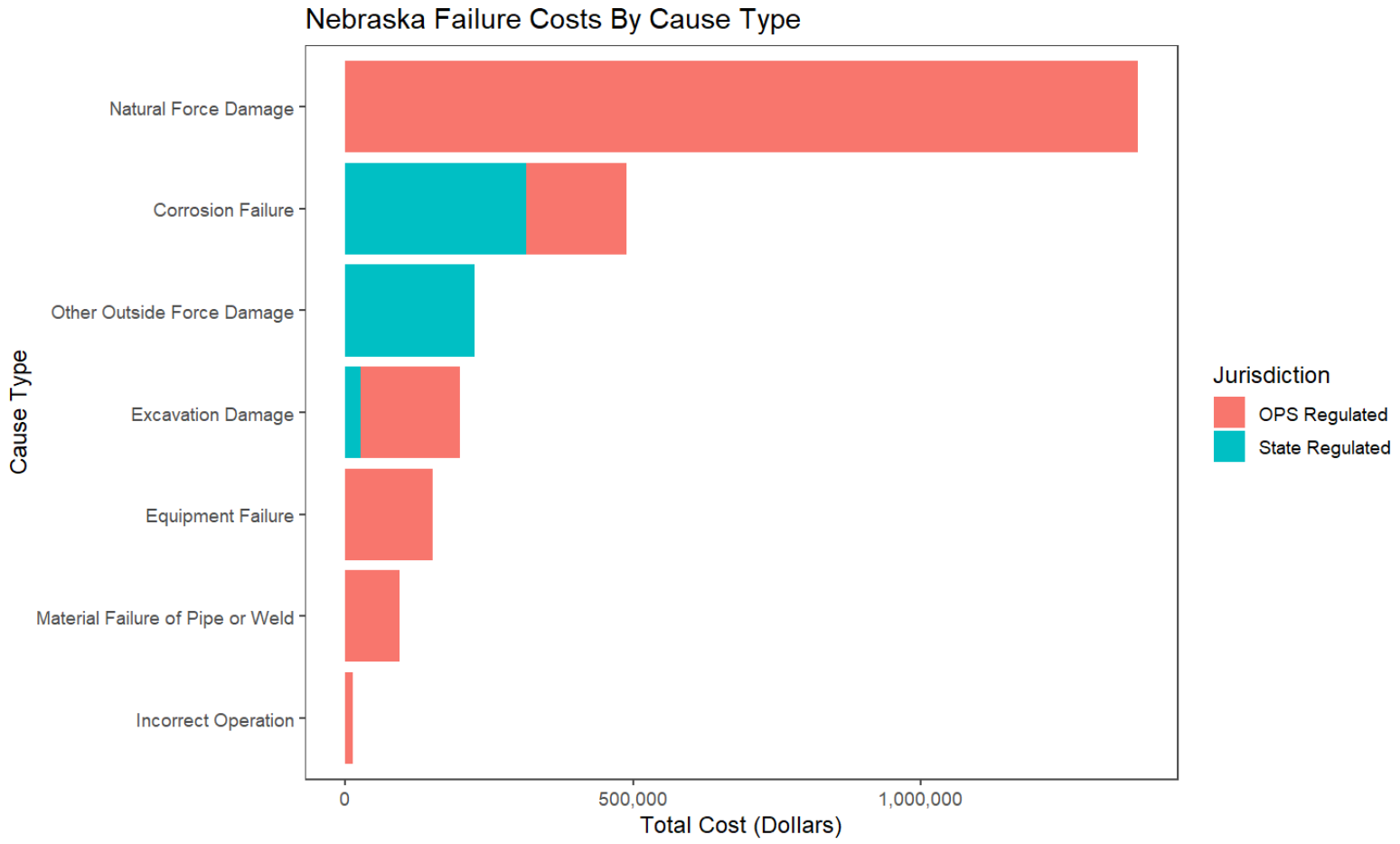
Nebraska Incidents - GD

Nebraska GD Incident Cause Type and Release Volume Above/Below the Median



*Data from January 2018 to January 2024

Nebraska Incidents

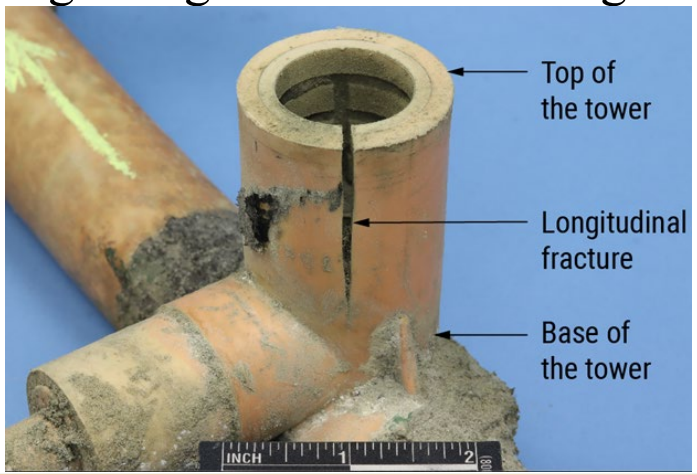


*Data from January 2018 to January 2024

Case Studies

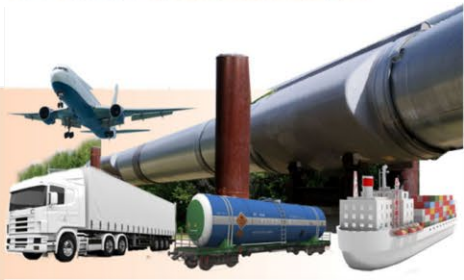
Case Study: Distribution Incident (2023)

- Natural gas-fueled explosion in West Reading, PA
- 7 fatalities and 11 injuries
- Many evacuations
- Involved vintage 1.25-inch Aldyl A plastic main
- NTSB led investigation
- Advisory Bulletin: https://pipelinesafety.dot.gov/regulations/federal-register-documents/07-4309



Case Study: Distribution Incident (2020)

- Rupture of 12-inch HDPE, installed in 2019
- Emergency responder notification
- Release of natural gas, operating at 95 psig
- A main road was damaged, causing a vehicle to overturn
- The incident was caused by butt fusion failure
- Inadequate interfacial pressure during the fusion process
- And/or excessive dwell time between heat soak and joining phases
- Failure to follow appropriate installation and inspection procedures



Case Study: Distribution Incident (2021)

- Failure at an assembly, including an 8-inch PE pipe, an 8-inch PE valve, and an 8-inch to 12-inch transition fitting.
- Emergency responder made the notification
- This assembly was installed in 2019
- Main was operating at 43 psig
- There were no injuries or fatalities
- The incident was caused by butt fusion failure
- The melt surface on the 8-inch pipe had a concave appearance
- It may have been caused by excessive pressure during the fusion process or a cold fusion
- Construction practices: poor workmanship

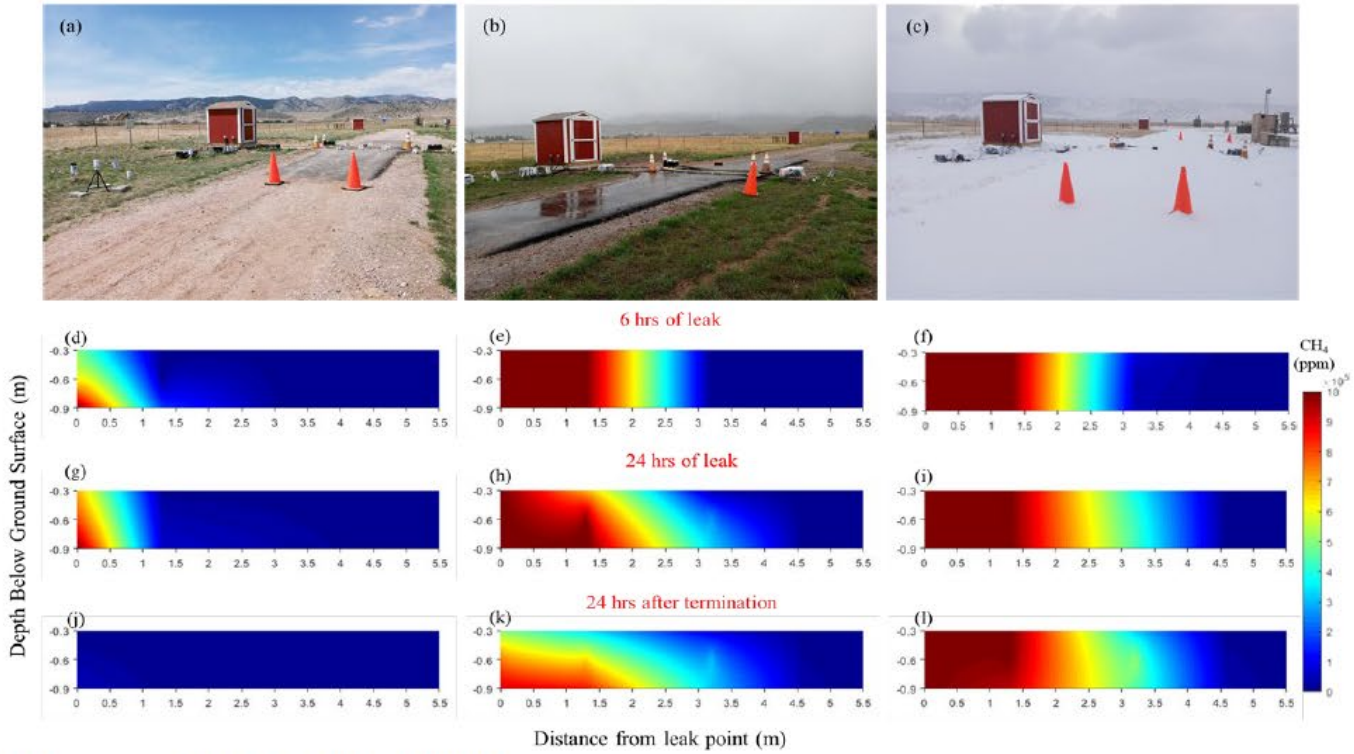
Case Study: Transmission (2023)

- A third-party wheel loader struck the 10-inch pipeline within a cattle feedlot during maintenance operations.
- The third party did not make a One-Call.
- Investigation is on-going.

Trends & Insights From AID

Leak Detection

Example: Effect of Surface Cover



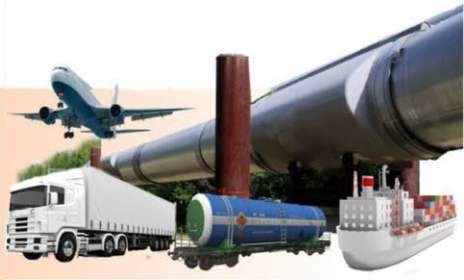
LEL = 50,000 ppm (5% CH_4 V/V)

UEL = 150,000 ppm (15% CH_4 V/V)

Jayarathne, Smits, Zimmerle., 2022, METEC Research Alert
Zimmerle, Smits, Jayarathne, 2022, METEC Research Alert

Trenchless Technology

- Unique characteristics of Horizontal Directional Drilling (HDD) increase the potential consequences of damage
  - Typically, congested areas/pavement
  - Gas migration vs. direct to atmosphere
  - Release isolation complexity increases
  - Are emergency procedures adequate? Isolation Plan?



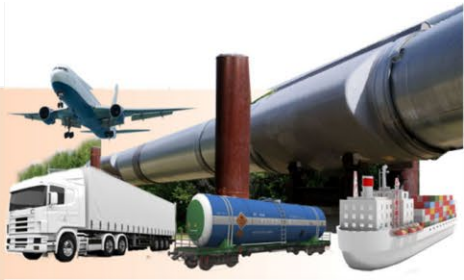
Trenchless Technology

- Require visual verification (Daylighting) of crossings
- Evaluate one-calls for HDD
  - Know Where They're Crossing You
  - Know Who's Doing the Work
  - Know They Excavate Safely
- Pre-Plan Emergency Response for Each Known Crossing
- Treat Every Single Crossing Knowing Lives Are in the Balance
- Train Personnel on the Special Concerns with HDD

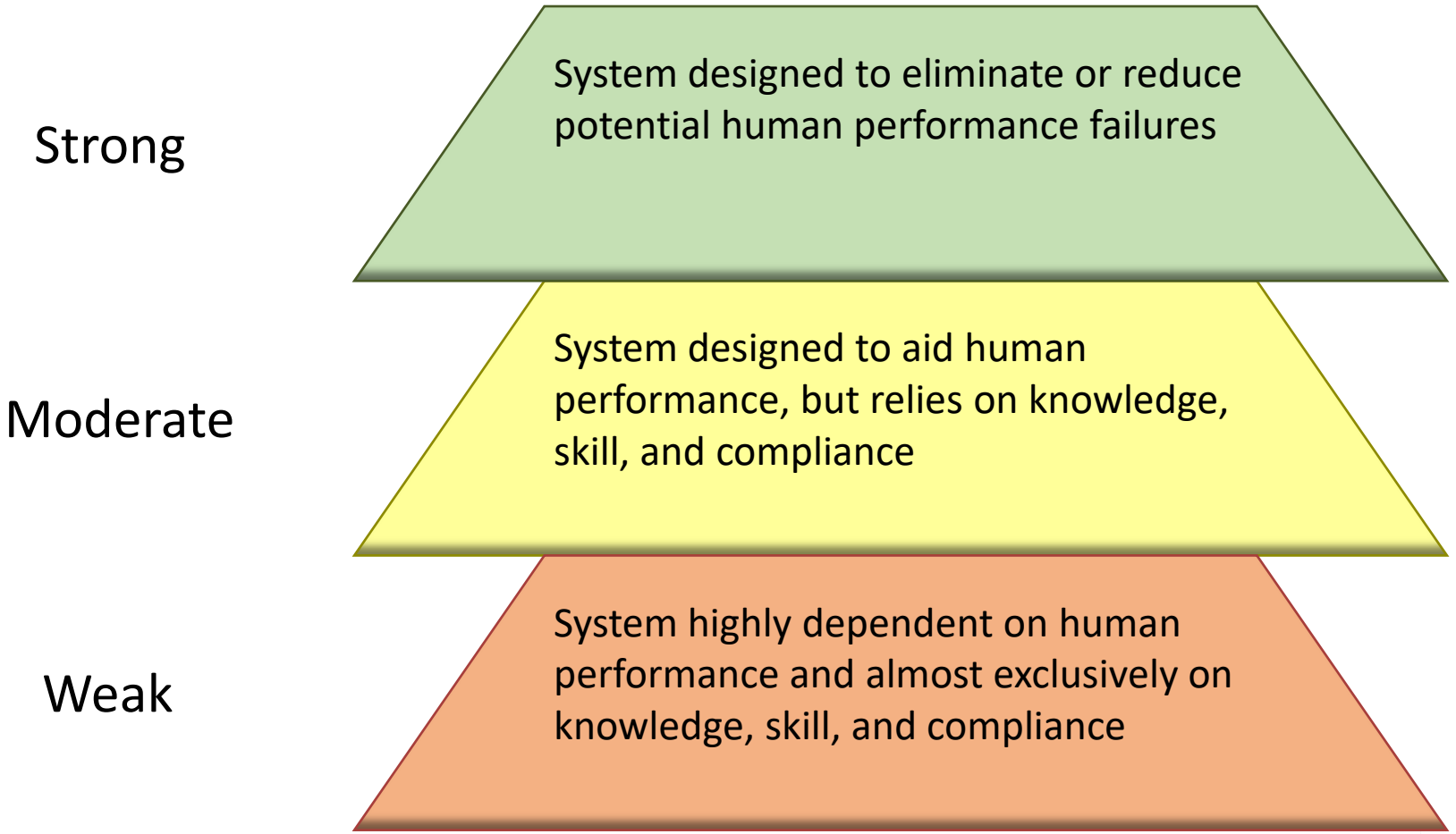
Human Factors

*Applying what we know about **people**, their abilities, characteristics, and limitations to the design of **equipment** they use, **environments** in which they function, and **jobs** they perform.*

- AID now has a human factors engineer on staff (me!)
- Working to improve our investigation methodology
  - Many of our Risk Factors are human-centric
  - Get to "why" those errors occur
- Working to avoid the "bad apple" approach
  - "Use Error", not "User Error"



Human Factors & System Design



Questions

Pipeline and Hazardous Materials Safety Administration (PHMSA) - Office of Pipeline Safety (OPS)

Accident Investigation Division (AID)

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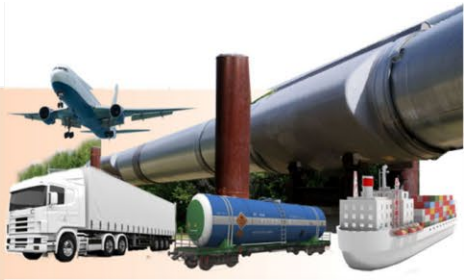


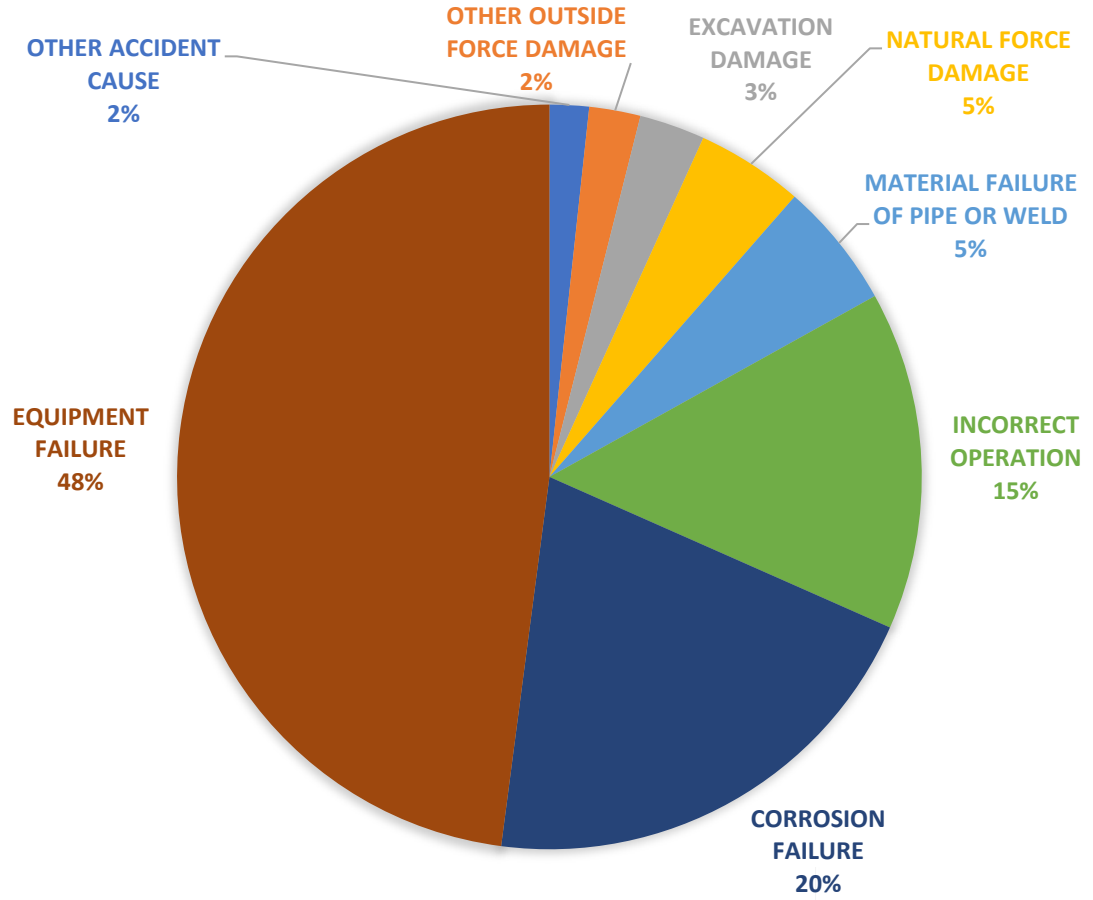
Appendix

Hazardous Liquid Accidents (2018 – August 2023)

EQUIPMENT FAILURE	926
NON-THREADED CONNECTION FAILURE	292
PUMP OR PUMP-RELATED EQUIPMENT	177
THREADED CONNECTION/COUPLING FAILURE	144
MALFUNCTION OF CONTROL/RELIEF EQUIPMENT	116
OTHER EQUIPMENT FAILURE	110
DEFECTIVE OR LOOSE TUBING OR FITTING	49
FAILURE OF EQUIPMENT BODY (EXCEPT PUMP), TANK PLATE, OR OTHER MATERIAL	38

CORROSION FAILURE	395
INTERNAL CORROSION	259
EXTERNAL CORROSION	136

Qty
HL: 1,932

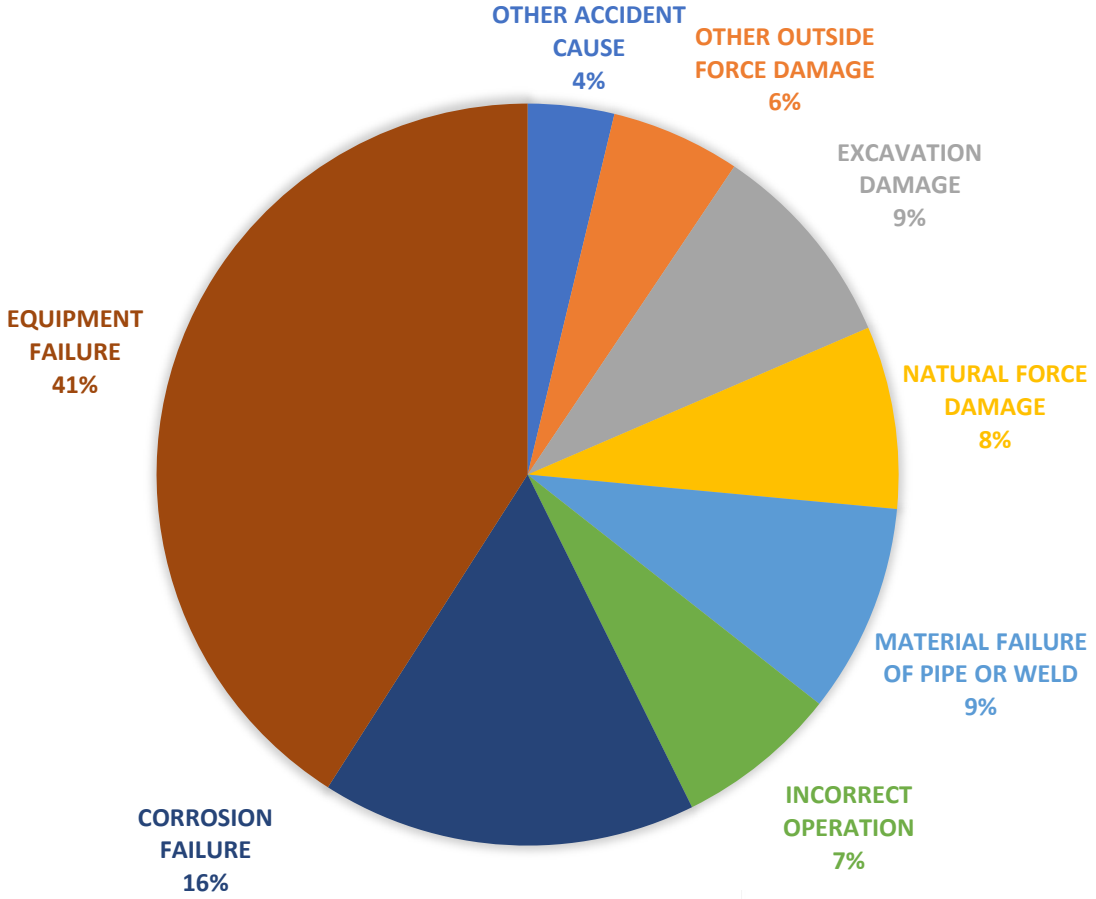


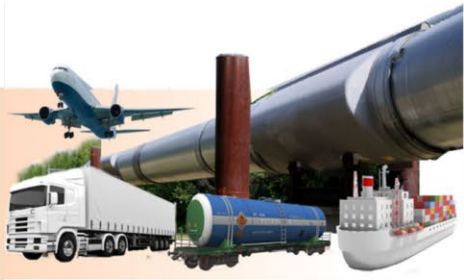
Gas Transmission Incidents (2018 – August 2023)

EQUIPMENT FAILURE	283
MALFUNCTION OF CONTROL/RELIEF EQUIPMENT	180
OTHER EQUIPMENT FAILURE	28
THREADED CONNECTION/COUPLING FAILURE	26
NON-THREADED CONNECTION FAILURE	19
COMPRESSOR OR COMPRESSOR-RELATED EQUIPMENT	15
DEFECTIVE OR LOOSE TUBING OR FITTING	11
FAILURE OF EQUIPMENT BODY (EXCEPT COMPRESSOR), VESSEL PLATE, OR OTHER MATERIAL	4

CORROSION FAILURE	113
INTERNAL CORROSION	61
EXTERNAL CORROSION	52

Qty
GT: 691

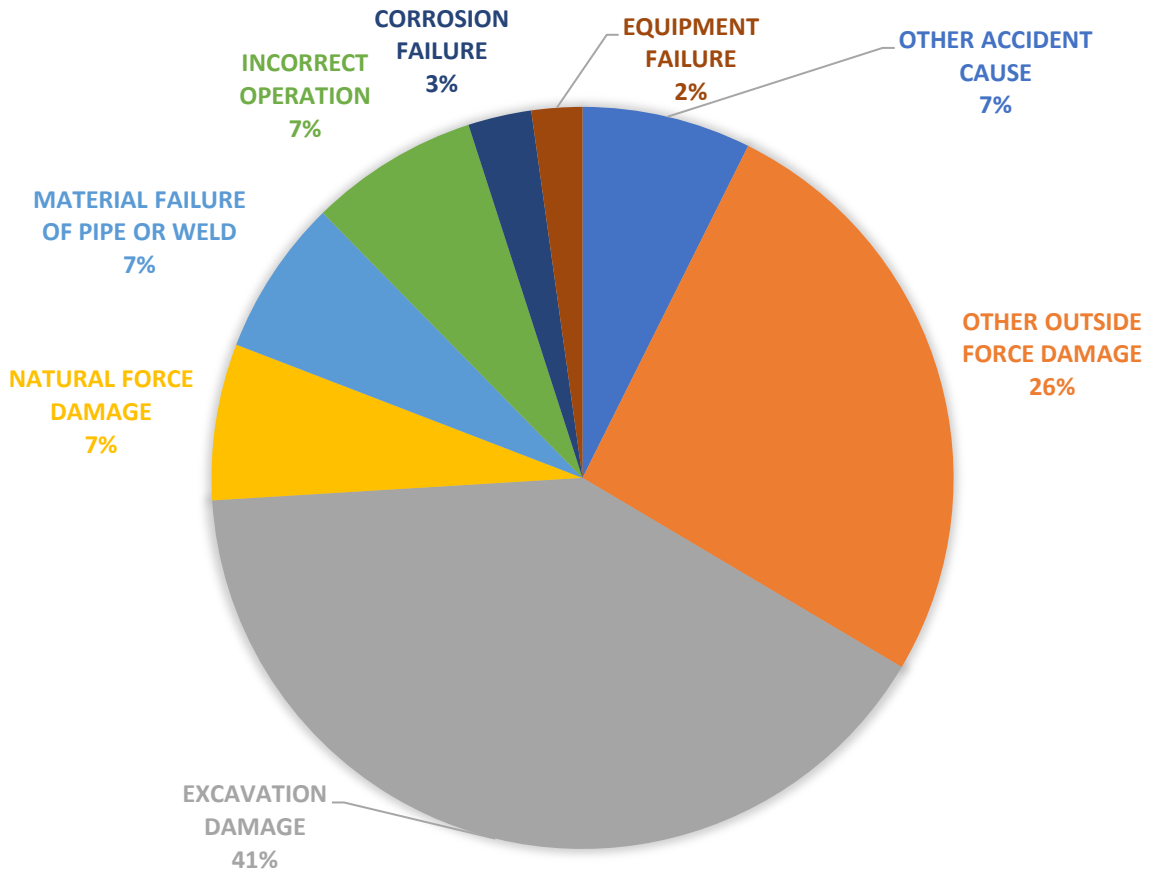




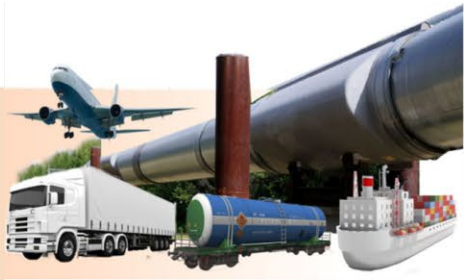
Gas Distribution Incidents (2018 – August 2023)

EXCAVATION DAMAGE	220
THIRD PARTY	191
OPERATOR'S CONTRACTOR (SECOND PARTY)	15
PREVIOUS DAMAGE DUE TO EXCAVATION ACTIVITY	9
OPERATOR (FIRST PARTY)	5

EXCAVATION DAMAGE	220
EXCAVATION PRACTICES NOT SUFFICIENT	108
LOCATING PRACTICES NOT SUFFICIENT	53
ONE-CALL NOTIFICATION PRACTICES NOT SUFFICIENT	45
OTHER	7
PREVIOUS DAMAGE	4
DATA NOT COLLECTED	3
EXCAVATION DAMAGE	220

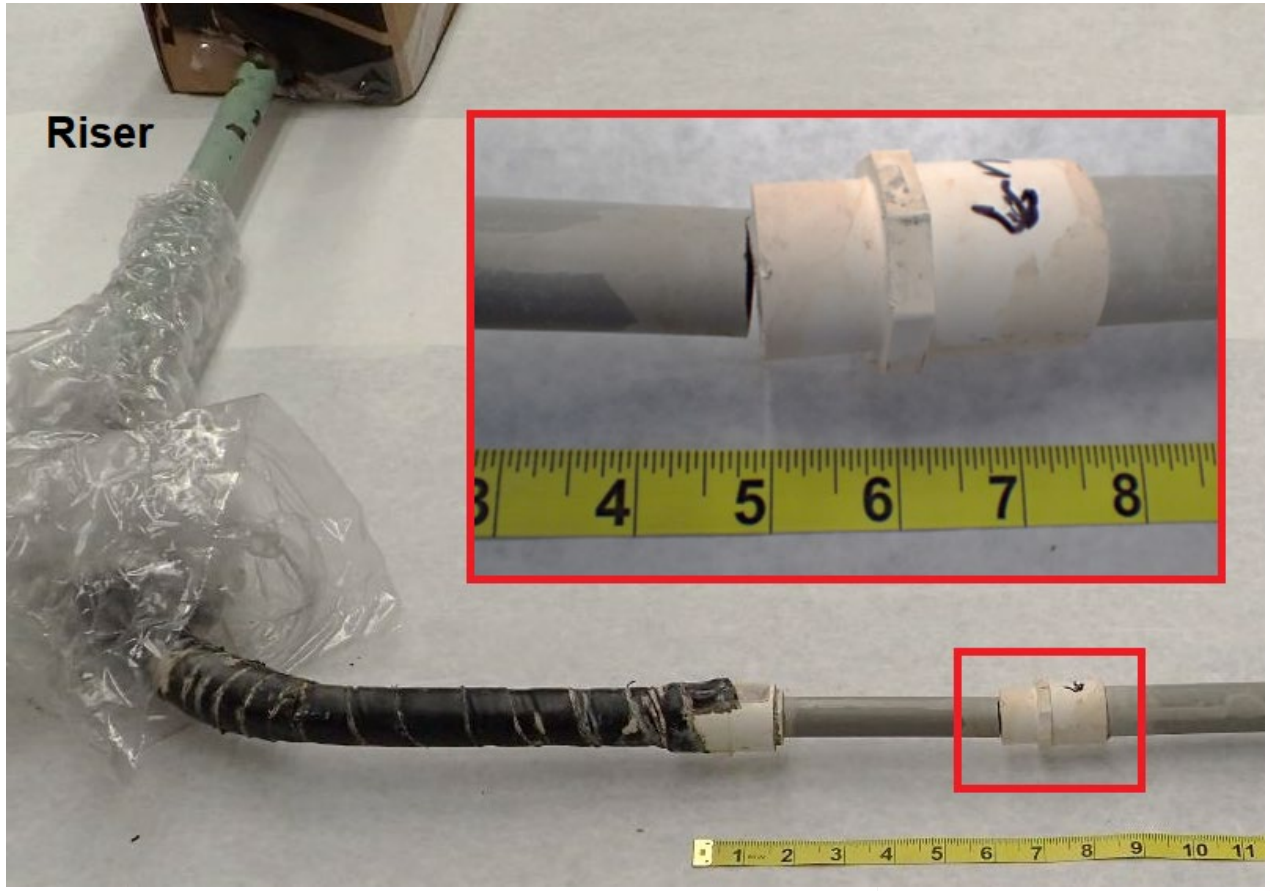


Qty
GD: 543



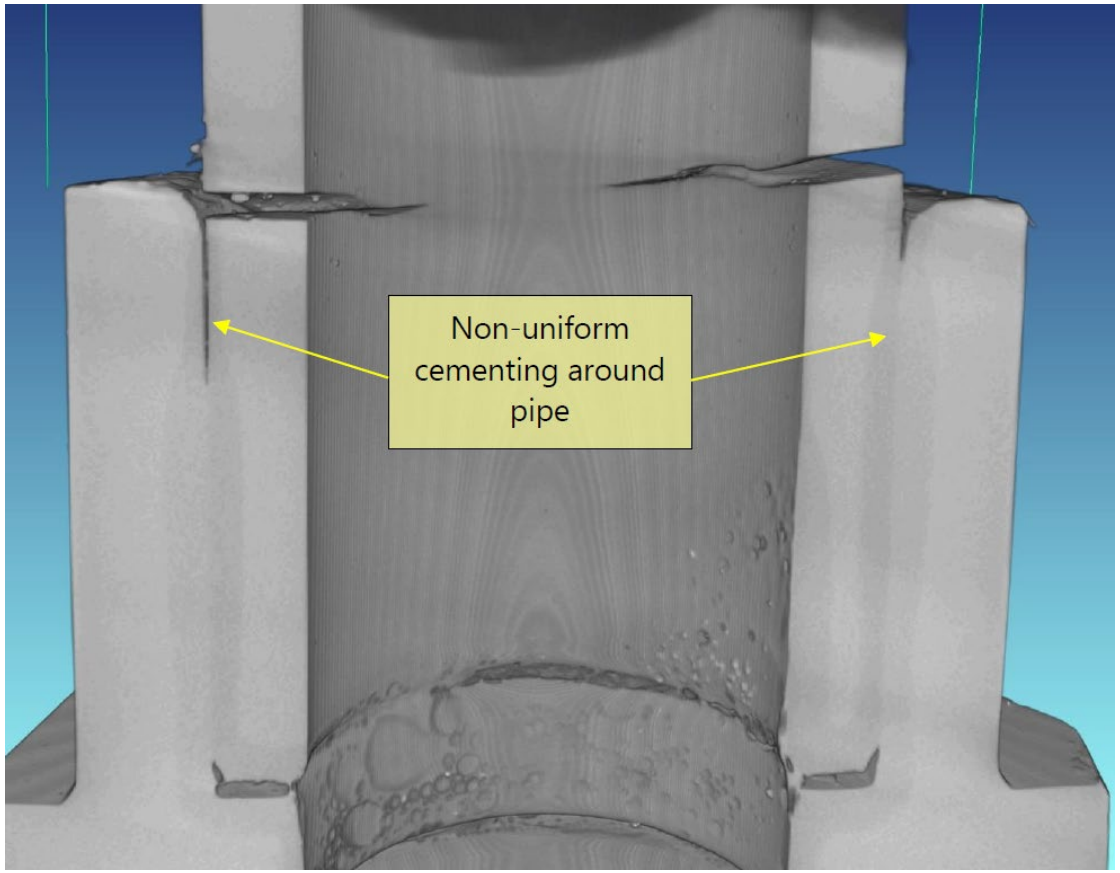
Case Study: Leak Detection and Replacement (2020)

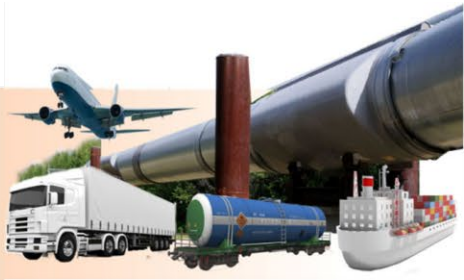
- Natural gas leak detected during an annual PVC leak survey, near a laundry room riser
- Gas reads indicated 1-4% LEL by the riser
- Meter was turned off, but ignition occurred inside the building
- After ignition, gas leak measurements were still increasing, 14 people and adjacent units were evacuated
- Failure of 1973 ½-inch PVC service pipeline
- The line was operating at 39 psig



Case Study: Leak Detection and Replacement (2020) – Cont'd

- Circumferential crack near the edge of the joint bond between the ½-inch pipe and the reducer fitting
- Non-uniform cementing around the joint
- The crack initiation area was at the bottom of the pipe's outer diameter
- The fracture surface exhibited smooth features, indicative of brittle fracture, slow crack growth, and creep rupture
- The field investigation determined that the bending loads may have been caused by a customer houseline water leak, which eroded the support from under the service line's transition fitting.





Close Interval Survey