SD/ND Conference March 2025

Accident Investigation Division (AID)

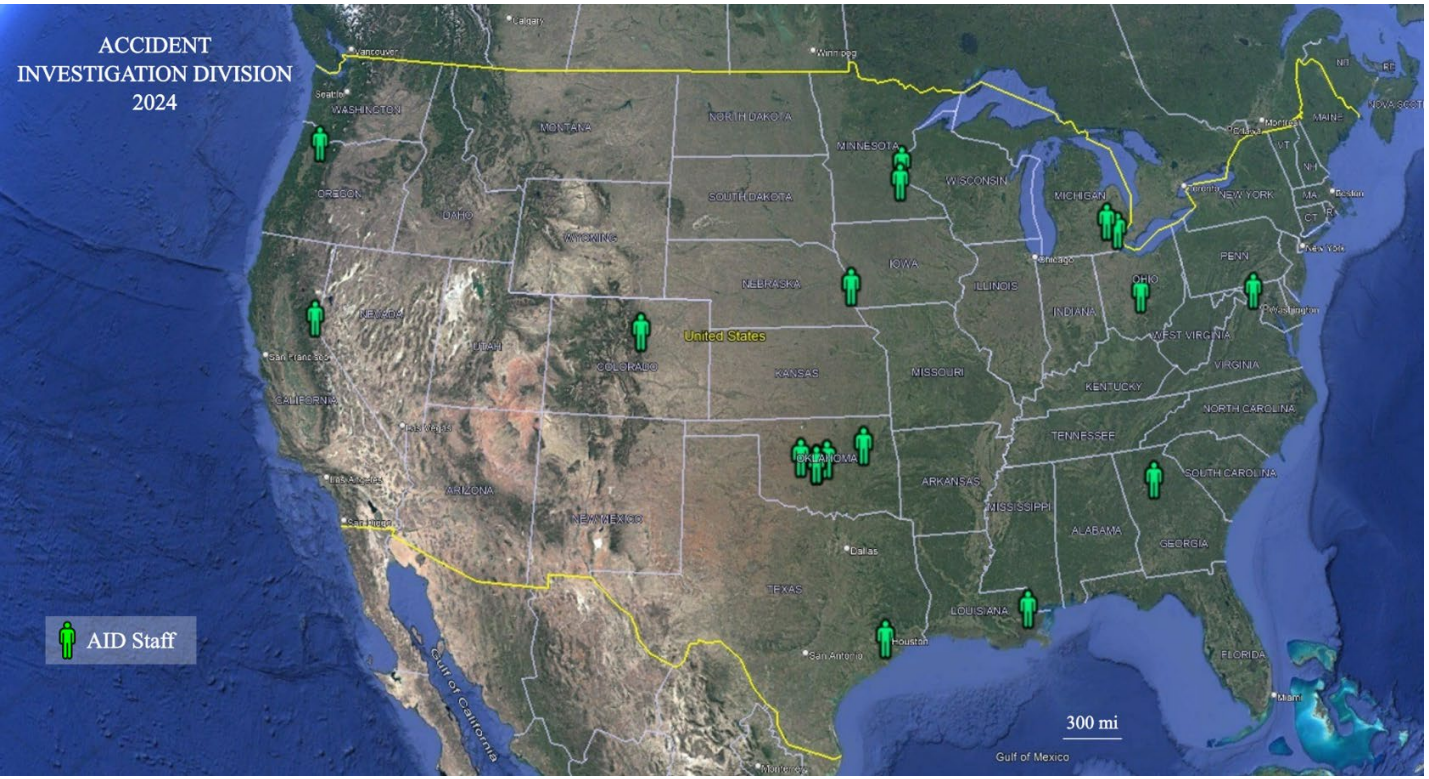
Darren Lemmerman

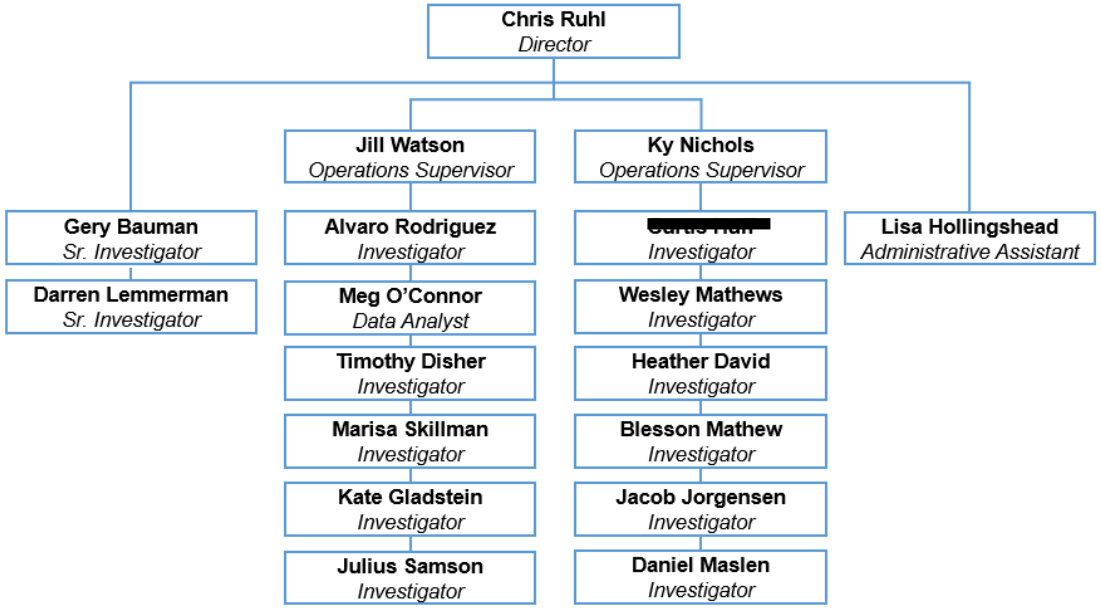
The history of Sioux Falls revolves around the cascades of the Big Sioux River. The Falls was created about 14,000 years ago when the last glacial ice sheet redirected the flow of the river into the large looping bends of its present course. The lure of the falls has been a powerful influence. Prehistoric people who inhabited the region before 500 B.C. left numerous burial mounds on the high bluffs near the river...

Outline

- **Who is AID?**
- **State Accidents**
- **National Accident/Incident Trends**
- **Leak Survey and Grading**
- **Atmos Dallas Case Study**

Accident Investigation Division

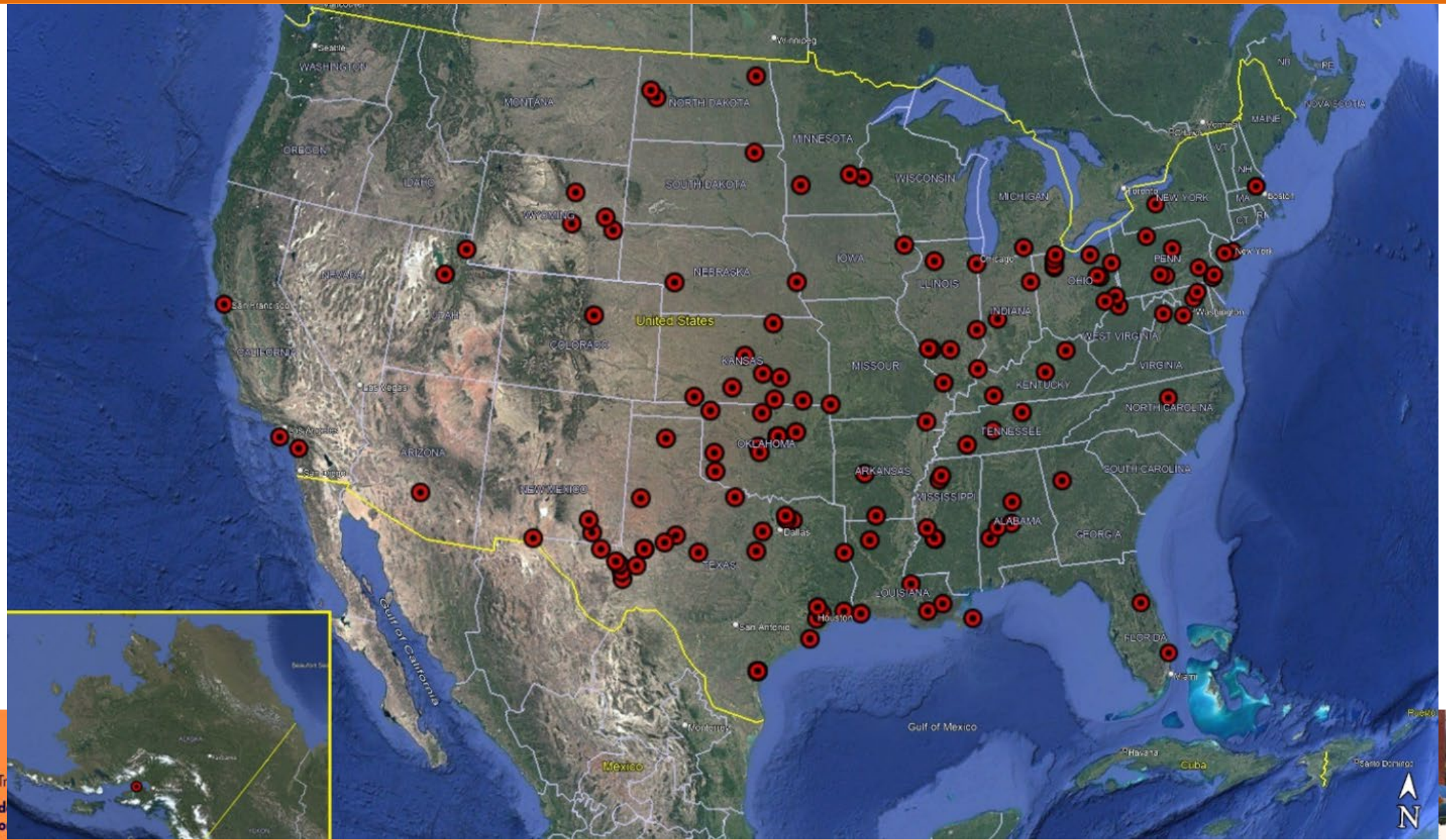




Accident Investigation Division

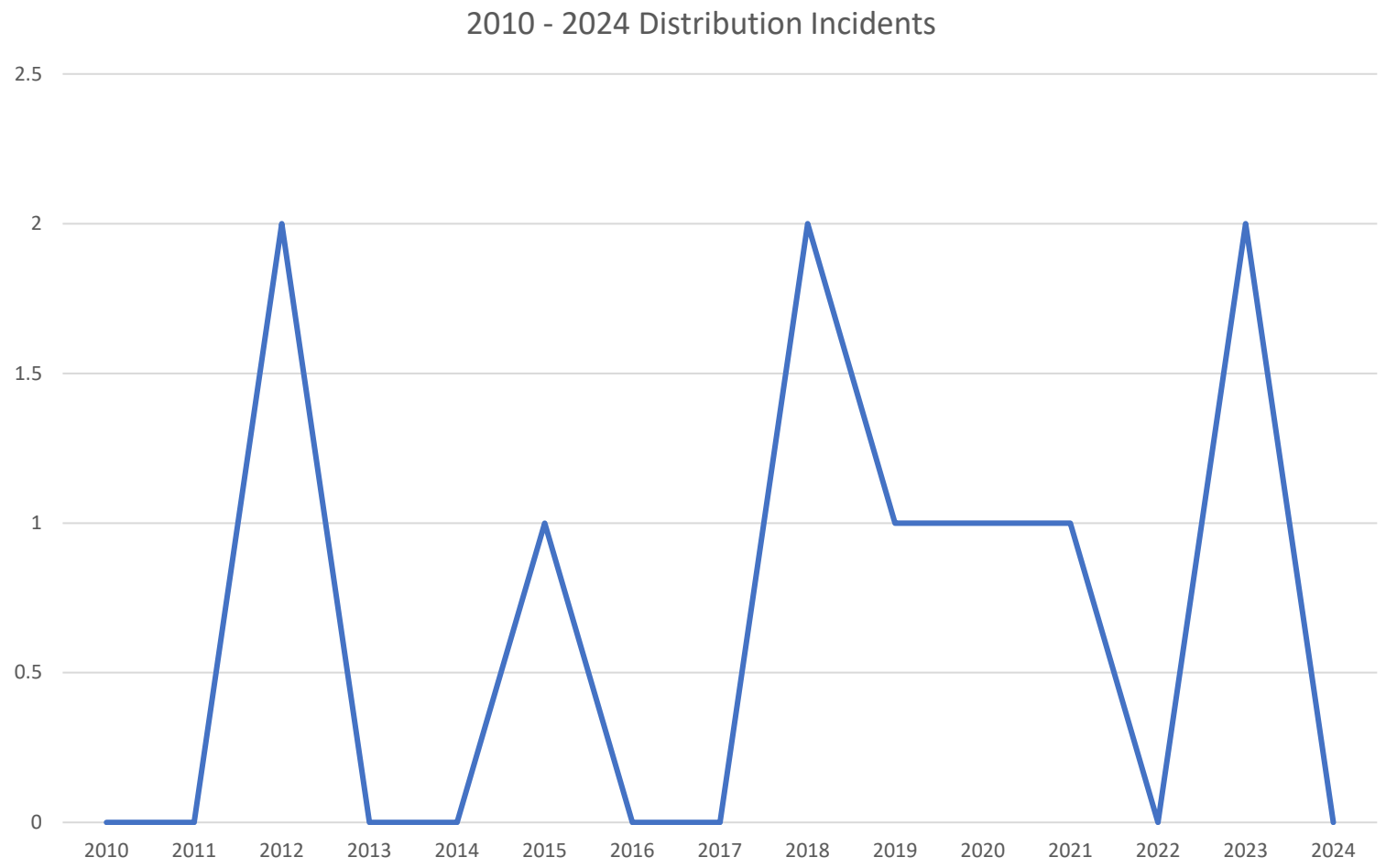
- AID was established on April 1, 2017
- Review, Evaluate, and Circulate NRC Notifications
- Manage Investigation from Initial NRC Notification through Cause Determination
- Conduct Onsite Accident Investigations: Support NTSB and State Investigations
- Review Operator 30-Day Accident/Incident Reports
- Publish State and Federal Monthly Accident Report Summaries (SMARS/MARS)
- Analyze Data to Identify Emerging Trends
- Capture and Share Lessons Learned (SAFE Bulletins, State Conferences, etc.)

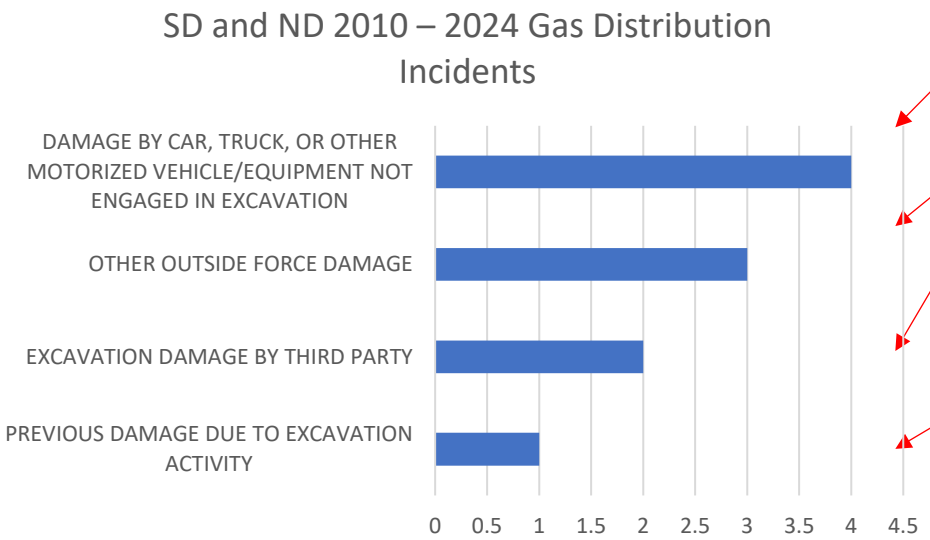
Accident Investigation Division Deployments 2018-2024

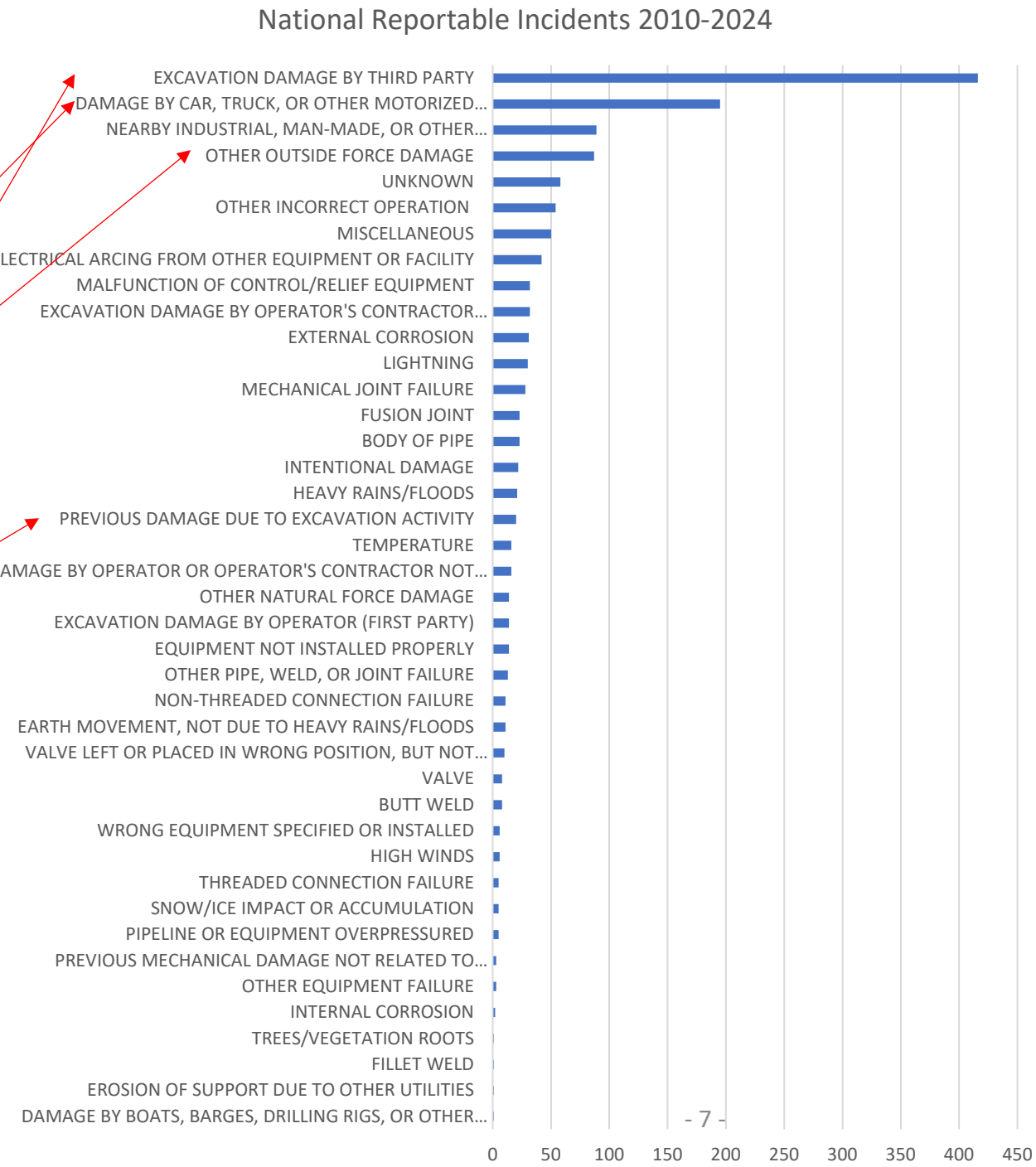


U.S. Department of Tr
Pipeline and Hazard
Safety Administratio

SD and ND Gas Distribution Incidents



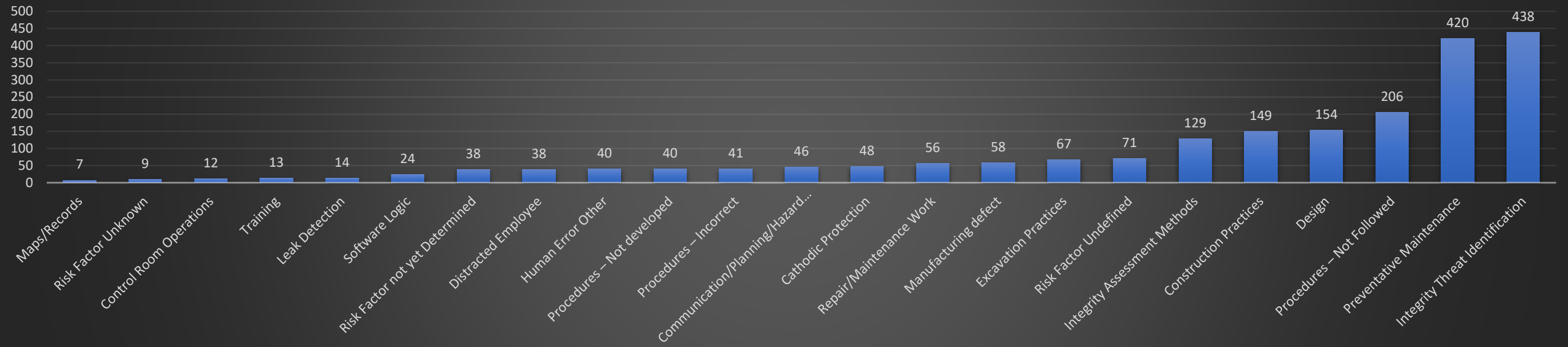

SD and ND 2010 – 2024 Gas Distribution Incidents
DAMAGE BY CAR, TRUCK, OR OTHER MOTORIZED VEHICLE/EQUIPMENT NOT ENGAGED IN EXCAVATION
OTHER OUTSIDE FORCE DAMAGE
EXCAVATION DAMAGE BY THIRD PARTY
PREVIOUS DAMAGE DUE TO EXCAVATION ACTIVITY
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5


National Reportable Incidents 2010-2024
EXCAVATION DAMAGE BY THIRD PARTY
DAMAGE BY CAR, TRUCK, OR OTHER MOTORIZED...
NEARBY INDUSTRIAL, MAN-MADE, OR OTHER...
OTHER OUTSIDE FORCE DAMAGE
UNKNOWN
OTHER INCORRECT OPERATION
MISCELLANEOUS
ELECTRICAL ARCING FROM OTHER EQUIPMENT OR FACILITY
MALFUNCTION OF CONTROL/RELIEF EQUIPMENT
EXCAVATION DAMAGE BY OPERATOR'S CONTRACTOR...
EXTERNAL CORROSION
LIGHTNING
MECHANICAL JOINT FAILURE
FUSION JOINT
BODY OF PIPE
INTENTIONAL DAMAGE
HEAVY RAINS/FLOODS
PREVIOUS DAMAGE DUE TO EXCAVATION ACTIVITY
TEMPERATURE
DAMAGE BY OPERATOR OR OPERATOR'S CONTRACTOR NOT...
OTHER NATURAL FORCE DAMAGE
EXCAVATION DAMAGE BY OPERATOR (FIRST PARTY)
EQUIPMENT NOT INSTALLED PROPERLY
OTHER PIPE, WELD, OR JOINT FAILURE
NON-THREADED CONNECTION FAILURE
EARTH MOVEMENT, NOT DUE TO HEAVY RAINS/FLOODS
VALVE LEFT OR PLACED IN WRONG POSITION, BUT NOT...
VALVE
BUTT WELD
WRONG EQUIPMENT SPECIFIED OR INSTALLED
HIGH WINDS
THREADED CONNECTION FAILURE
SNOW/ICE IMPACT OR ACCUMULATION
PIPELINE OR EQUIPMENT OVERPRESSURED
PREVIOUS MECHANICAL DAMAGE NOT RELATED TO...
OTHER EQUIPMENT FAILURE
INTERNAL CORROSION
TREES/VEGETATION ROOTS
FILLET WELD
EROSION OF SUPPORT DUE TO OTHER UTILITIES
DAMAGE BY BOATS, BARGES, DRILLING RIGS, OR OTHER...
0
50
100
150
200
250
300
350
400
450

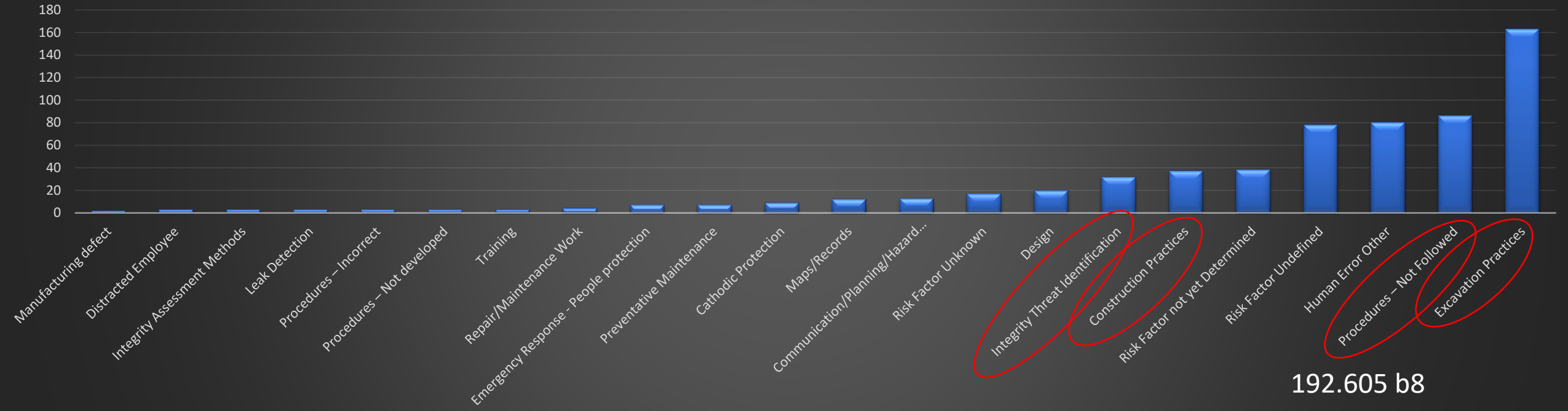
Outside the Box - Assigning Risk Factors

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

All Risk Factors 2018 - 2024



GD Risk Factors 2018-2024



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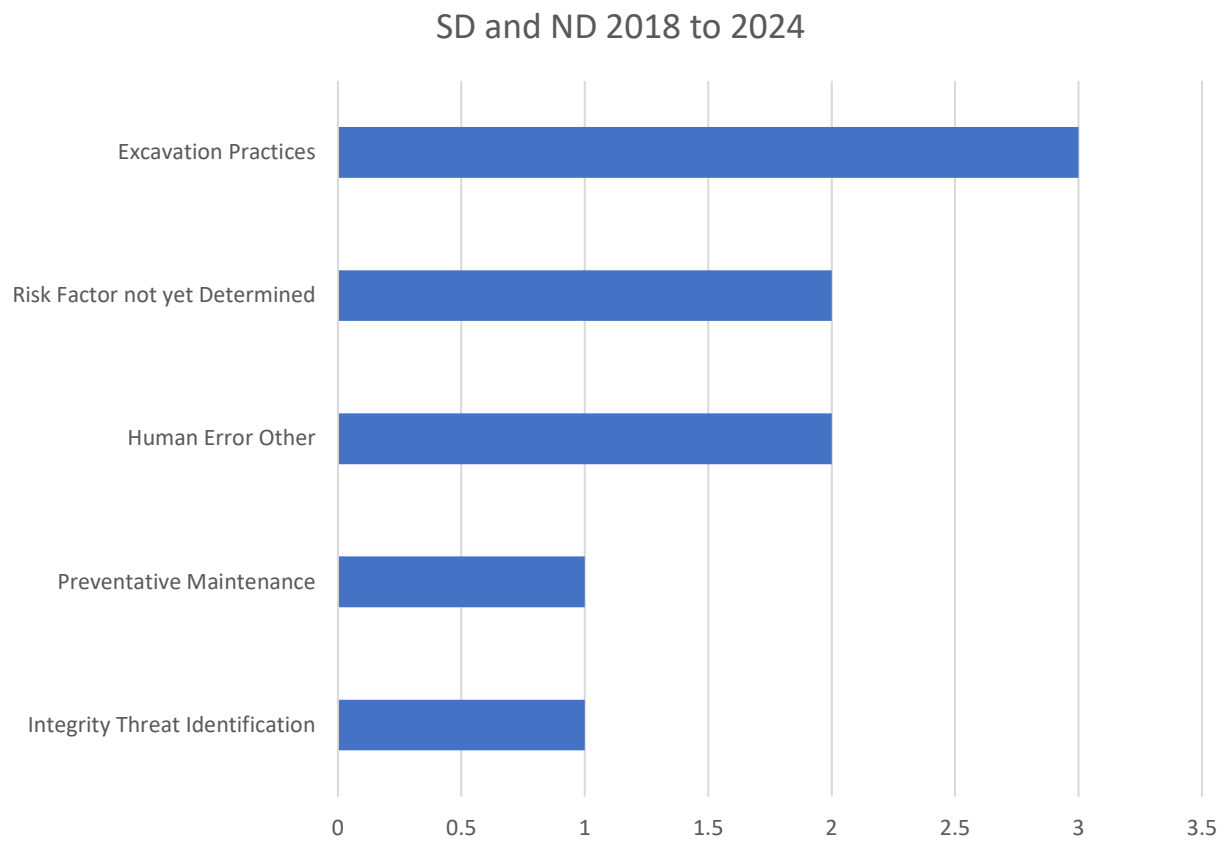
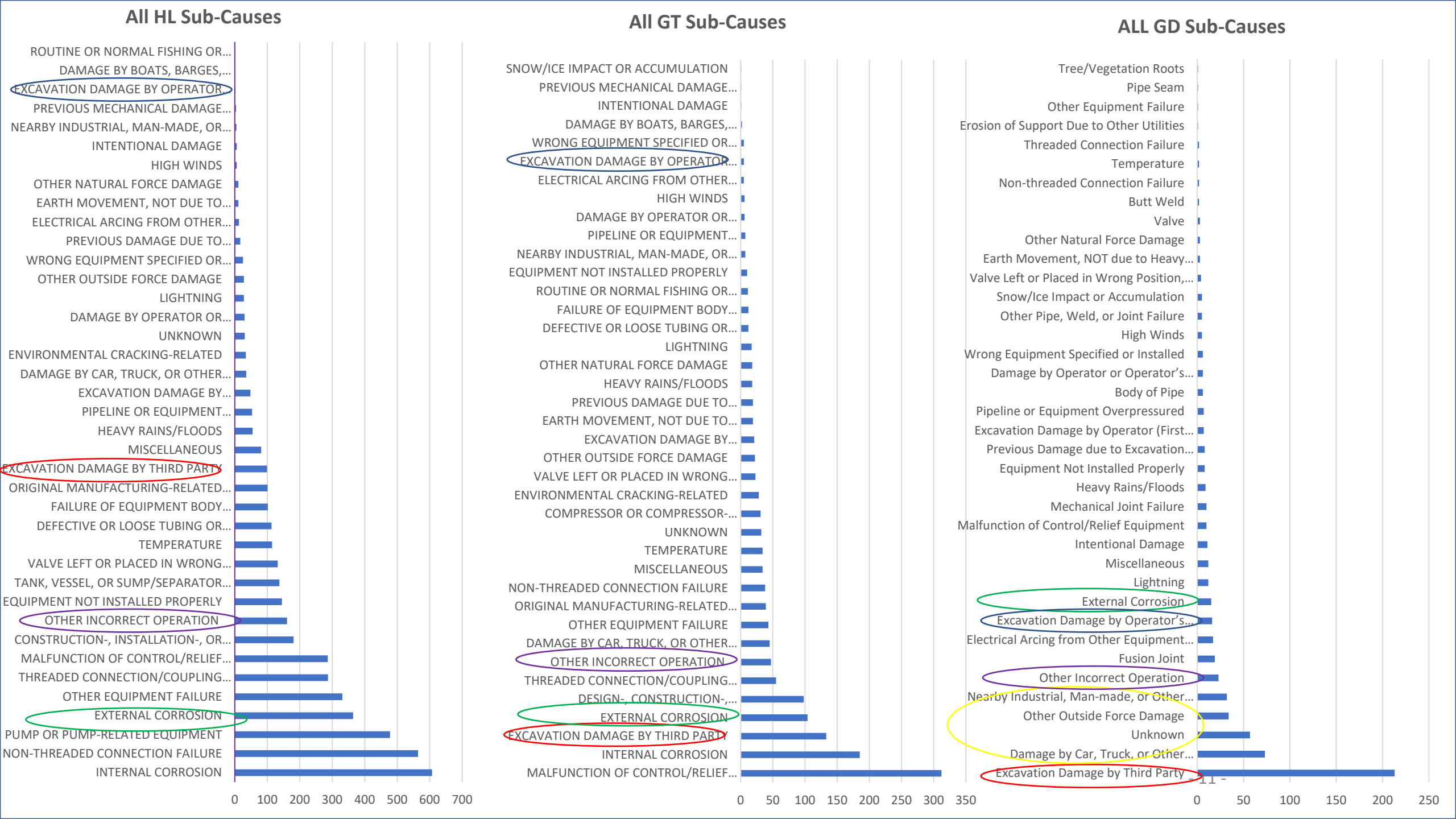
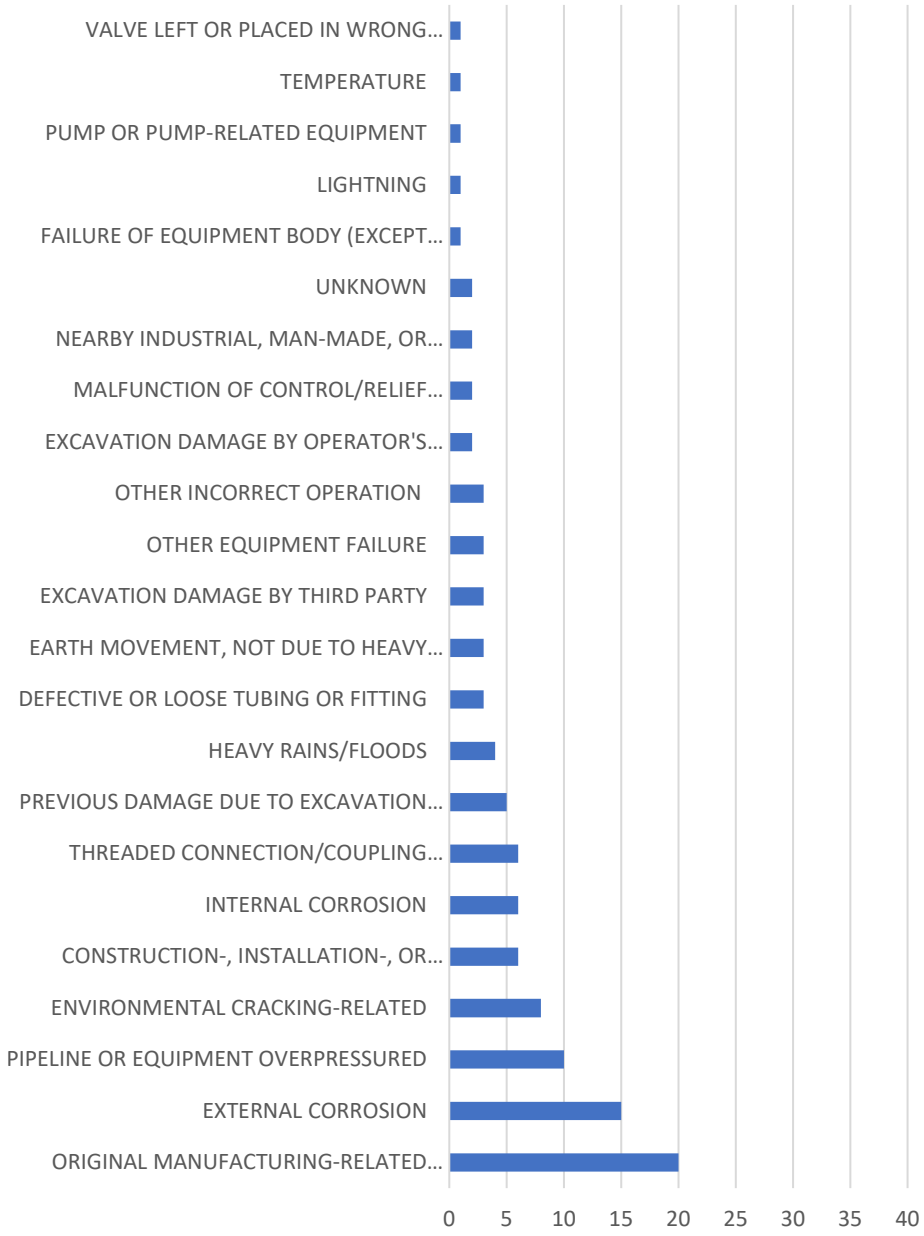
SD and ND Gas Distribution Risk Factors

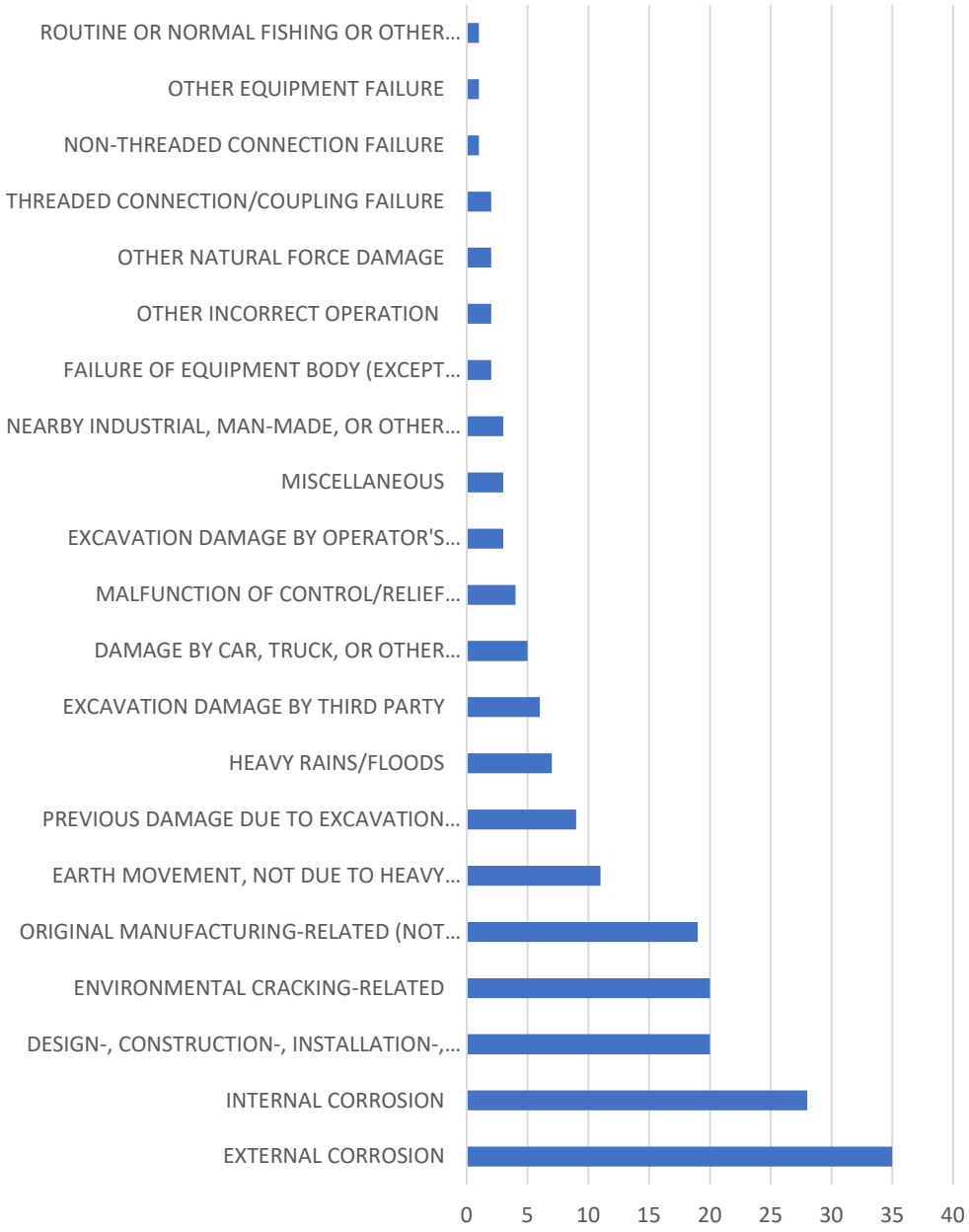



All HL Sub-Causes
ROUTINE OR NORMAL FISHING OR...
DAMAGE BY BOATS, BARGES,...
EXCAVATION DAMAGE BY OPERATOR...
PREVIOUS MECHANICAL DAMAGE...
NEARBY INDUSTRIAL, MAN-MADE, OR...
INTENTIONAL DAMAGE
HIGH WINDS
OTHER NATURAL FORCE DAMAGE
EARTH MOVEMENT, NOT DUE TO...
ELECTRICAL ARCING FROM OTHER...
PREVIOUS DAMAGE DUE TO...
WRONG EQUIPMENT SPECIFIED OR...
OTHER OUTSIDE FORCE DAMAGE
LIGHTNING
DAMAGE BY OPERATOR OR...
UNKNOWN
ENVIRONMENTAL CRACKING-RELATED
DAMAGE BY CAR, TRUCK, OR OTHER...
EXCAVATION DAMAGE BY...
PIPELINE OR EQUIPMENT...
HEAVY RAINS/FLOODS
MISCELLANEOUS
EXCAVATION DAMAGE BY THIRD PARTY
ORIGINAL MANUFACTURING-RELATED...
FAILURE OF EQUIPMENT BODY...
DEFECTIVE OR LOOSE TUBING OR...
TEMPERATURE
VALVE LEFT OR PLACED IN WRONG...
TANK, VESSEL, OR SUMP/SEPARATOR...
EQUIPMENT NOT INSTALLED PROPERLY
OTHER INCORRECT OPERATION
CONSTRUCTION-, INSTALLATION-, OR...
MALFUNCTION OF CONTROL/RELIEF...
THREADED CONNECTION/COUPLING...
OTHER EQUIPMENT FAILURE
EXTERNAL CORROSION
PUMP OR PUMP-RELATED EQUIPMENT
NON-THREADED CONNECTION FAILURE
INTERNAL CORROSION
0 100 200 300 400 500 600 700
All GT Sub-Causes
SNOW/ICE IMPACT OR ACCUMULATION
PREVIOUS MECHANICAL DAMAGE...
INTENTIONAL DAMAGE
DAMAGE BY BOATS, BARGES,...
WRONG EQUIPMENT SPECIFIED OR...
EXCAVATION DAMAGE BY OPERATOR...
ELECTRICAL ARCING FROM OTHER...
HIGH WINDS
DAMAGE BY OPERATOR OR...
PIPELINE OR EQUIPMENT...
NEARBY INDUSTRIAL, MAN-MADE, OR...
EQUIPMENT NOT INSTALLED PROPERLY
ROUTINE OR NORMAL FISHING OR...
FAILURE OF EQUIPMENT BODY...
DEFECTIVE OR LOOSE TUBING OR...
LIGHTNING
OTHER NATURAL FORCE DAMAGE
HEAVY RAINS/FLOODS
PREVIOUS DAMAGE DUE TO...
EARTH MOVEMENT, NOT DUE TO...
EXCAVATION DAMAGE BY...
OTHER OUTSIDE FORCE DAMAGE
VALVE LEFT OR PLACED IN WRONG...
ENVIRONMENTAL CRACKING-RELATED
COMPRESSOR OR COMPRESSOR-...
UNKNOWN
TEMPERATURE
MISCELLANEOUS
NON-THREADED CONNECTION FAILURE
ORIGINAL MANUFACTURING-RELATED...
OTHER EQUIPMENT FAILURE
DAMAGE BY CAR, TRUCK, OR OTHER...
OTHER INCORRECT OPERATION
THREADED CONNECTION/COUPLING...
DESIGN-, CONSTRUCTION-,...
EXTERNAL CORROSION
EXCAVATION DAMAGE BY THIRD PARTY
INTERNAL CORROSION
MALFUNCTION OF CONTROL/RELIEF...
0 50 100 150 200 250 300 350
ALL GD Sub-Causes
Tree/Vegetation Roots
Pipe Seam
Other Equipment Failure
Erosion of Support Due to Other Utilities
Threaded Connection Failure
Temperature
Non-threaded Connection Failure
Butt Weld
Valve
Other Natural Force Damage
Earth Movement, NOT due to Heavy...
Valve Left or Placed in Wrong Position,...
Snow/Ice Impact or Accumulation
Other Pipe, Weld, or Joint Failure
High Winds
Wrong Equipment Specified or Installed
Damage by Operator or Operator's...
Body of Pipe
Pipeline or Equipment Overpressured
Excavation Damage by Operator (First...
Previous Damage due to Excavation...
Equipment Not Installed Properly
Heavy Rains/Floods
Mechanical Joint Failure
Malfunction of Control/Relief Equipment
Intentional Damage
Miscellaneous
Lightning
External Corrosion
Excavation Damage by Operator's...
Electrical Arcing from Other Equipment...
Fusion Joint
Other Incorrect Operation
Nearby Industrial, Man-made, or Other...
Other Outside Force Damage
Unknown
Damage by Car, Truck, or Other...
Excavation Damage by Third Party
0 50 100 150 200 250

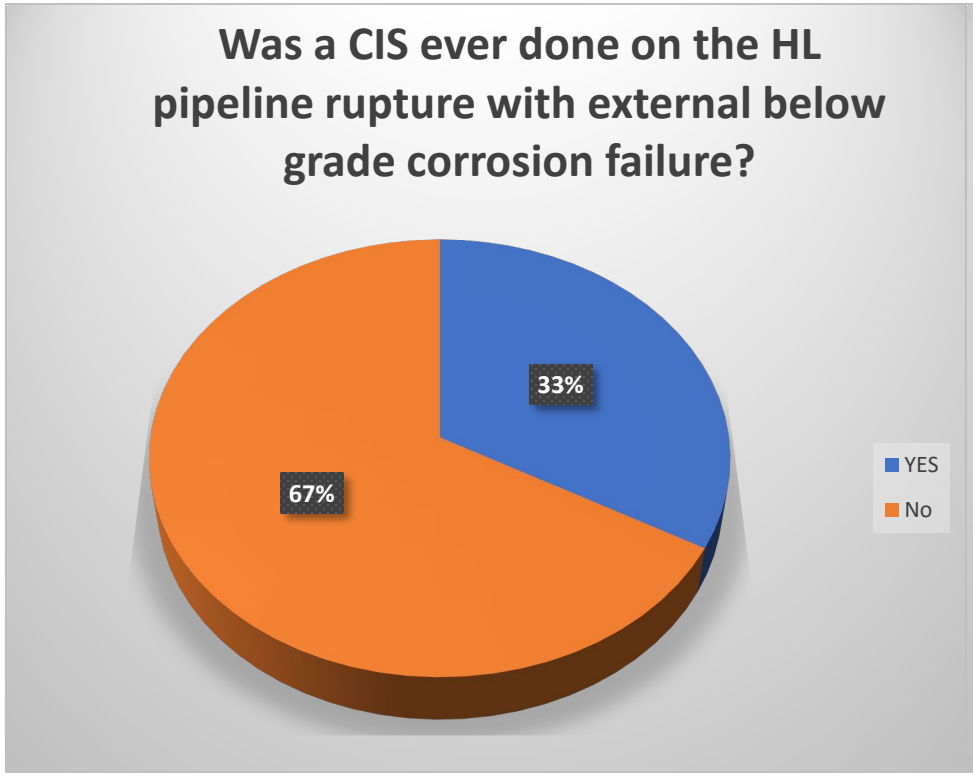
HL Failures Resulting in **108 Ruptures**

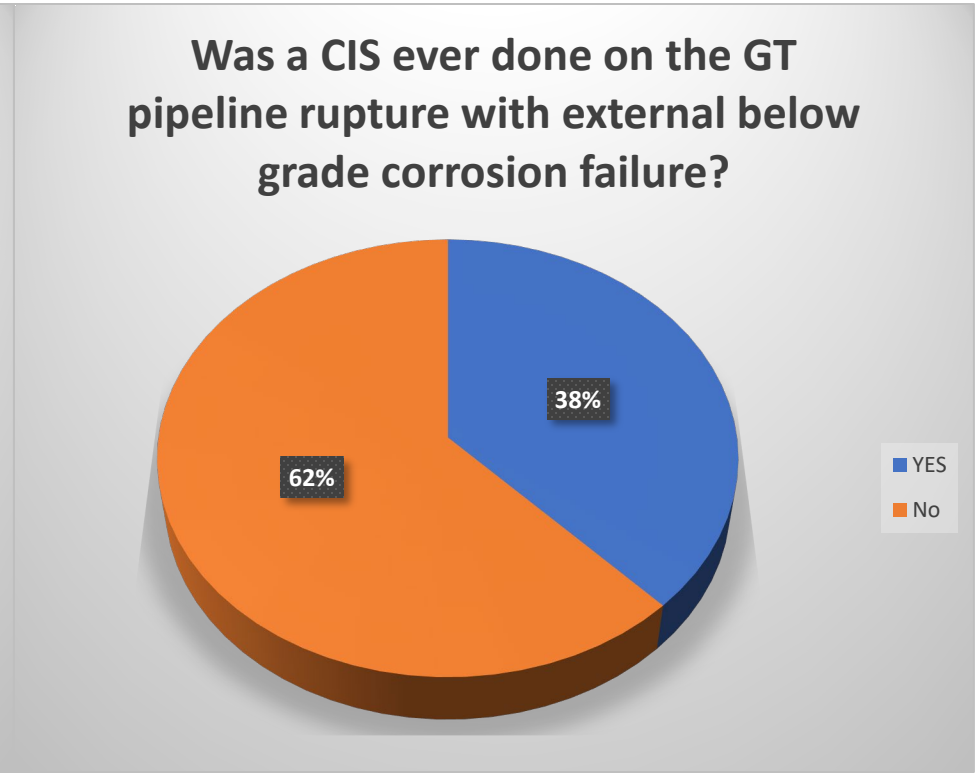


GT Failures Resulting in **184 Ruptures**



Close Interval Survey





Cathodic Protection

- Test stations only provide data at the test point. There are 5279 feet of pipe with unknown potentials to the next one-mile test station. Only a close interval survey can reveal the protection between test points.

- Minimum CP potential of rusted mild steel, as noted in the Galvanic Series, is -200mv and any reading taken less negative is being influence by outside sources, such a being shorted to the electrical grid or critical interference. (heavily rusted steel can be as low as -200mv)

- CP stops corrosion with -1100mv of potential. O_2 has been eliminated at the surface of the pipe.
  O_2 Reduction Formula $O_2 + H_2O + 4e^- > 4\ OH^-$

- Potentials above -1100mv are achievable with a maximum of -1200mv, all energy beyond goes to splitting water and additional potential is not possible. Known as “Excess CP”
  H_2O Reduction Formula $2H_2O + 4e^- > H_2 + 2\ OH^-$

- Survey potentials must be -200mv to -1200mv anything else is influenced and does not demonstrate a criteria.

Inadequate Compaction

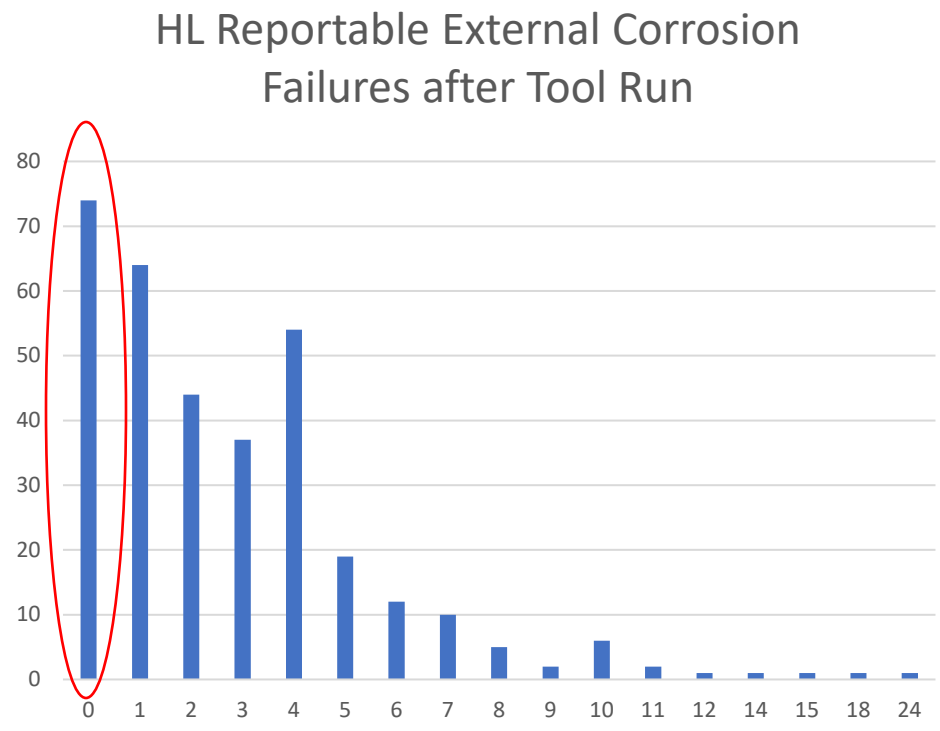
Girth weld failures and where do they occur?

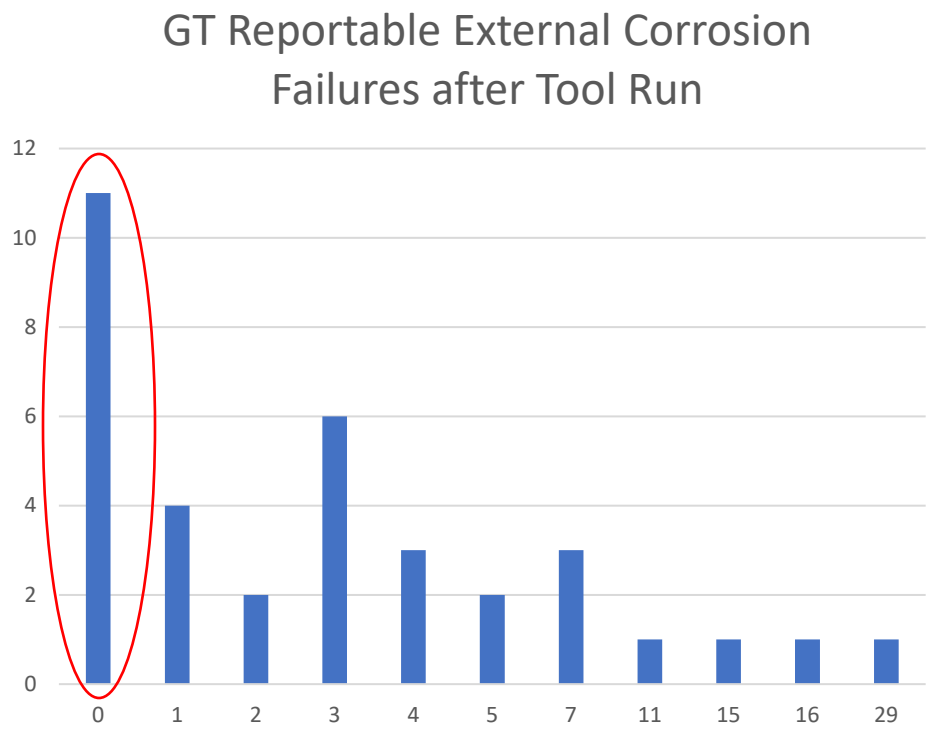
- New construction at tie-ins
- Repairs
- Earth movement
- Installation of other utilities

Prevention

- Compaction procedures
- Compaction testing
- Oversight

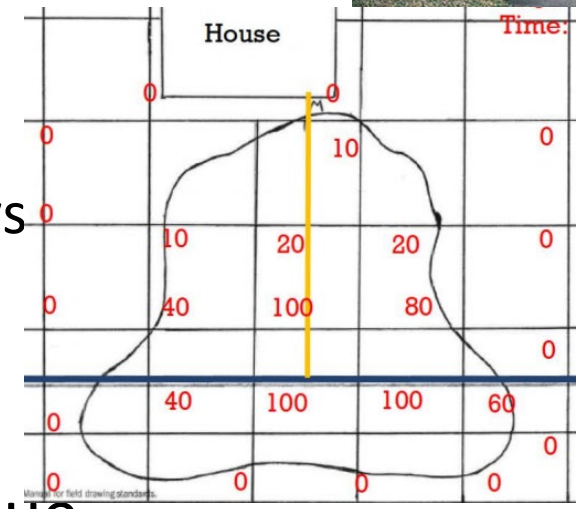
External Corrosion after Tool Run





Leak Investigation

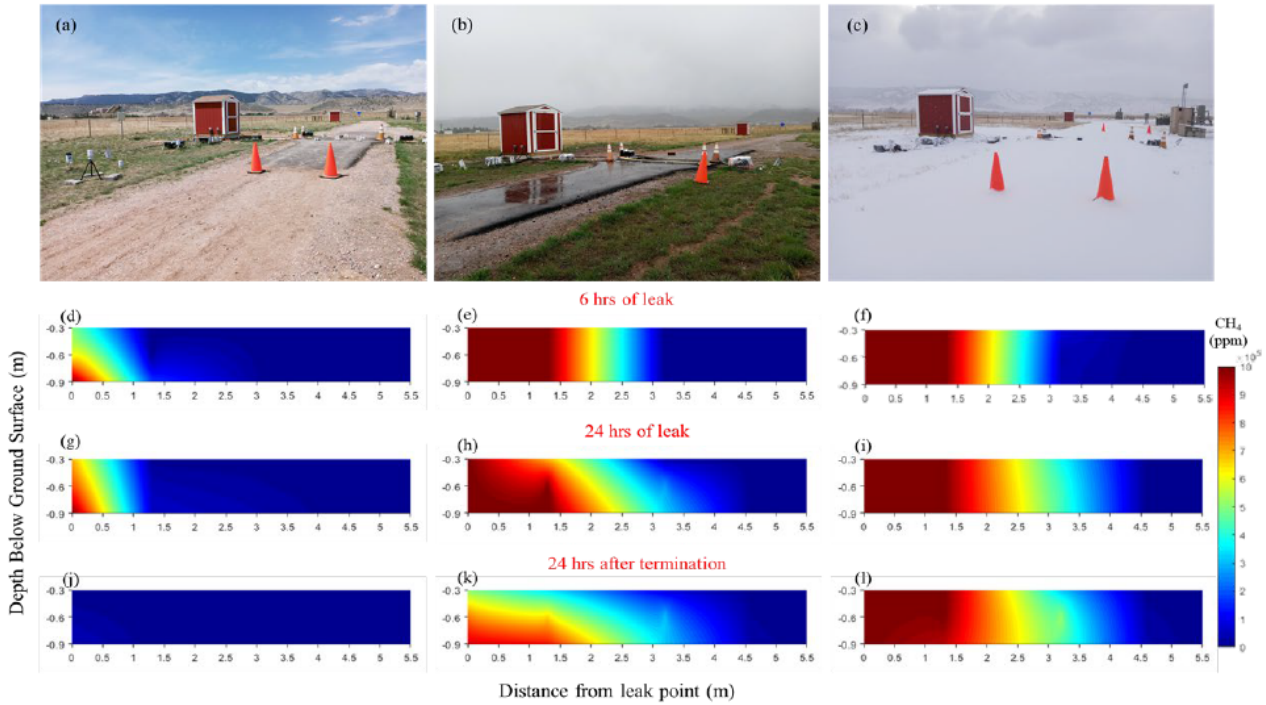
- Determine leak location using Flame Ionization (FI) Unit
- Pinpoint leak: determine leak spread by bar holing until 0% gas obtained in all directions
- Check several nearby houses
  - If no one is home, check doors and windows
  - If a positive reading is obtained, evacuate
- Check nearby manholes
- If you find any positive gas reads, continue your investigation.



Leak Investigation

Current Understanding from Experiments

Example: Effect of Surface Cover



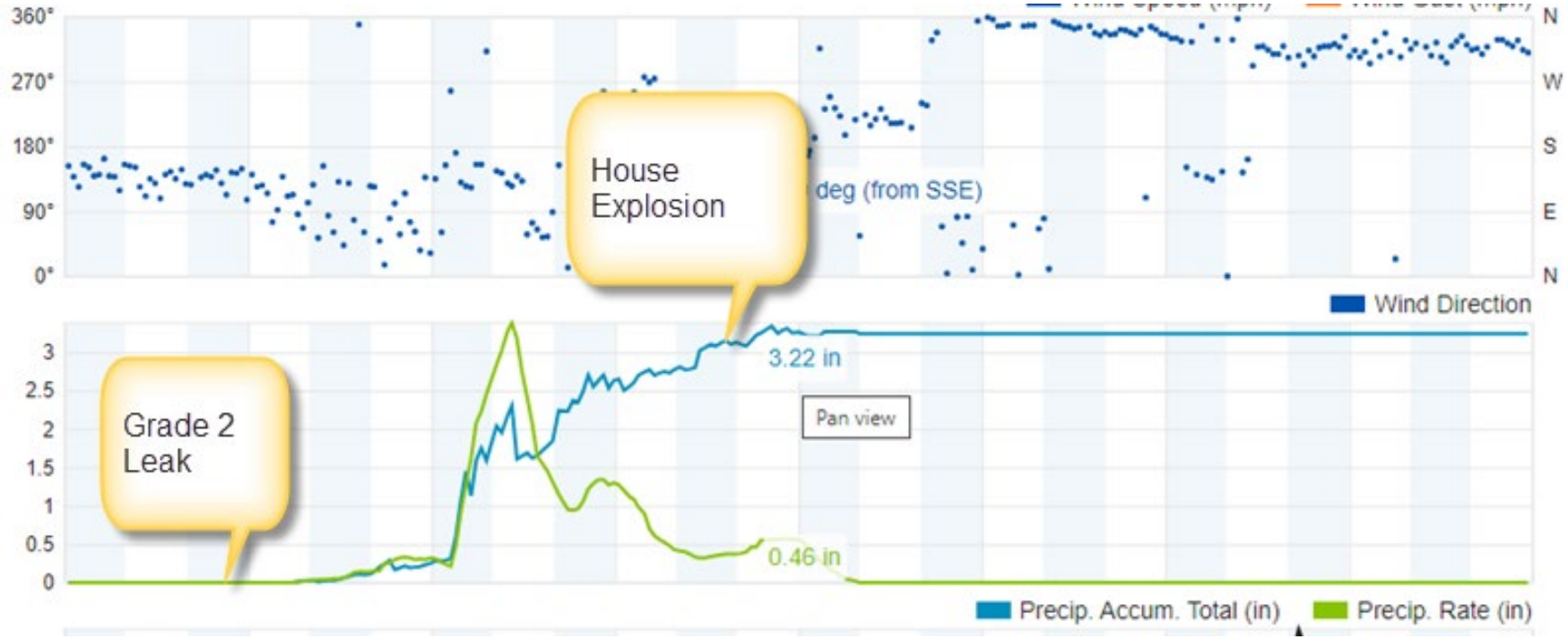
LEL = 50,000 ppm (5% CH_4 V/V)

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

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

ENERGY INSTITUTE Colorado State University SMU

Leak Investigation



* Each bar represents 1-hour. 5 hours of heavy rain capped the gas plume. Leak was graded 3 months prior to explosion.

Case Study
Atmos Energy
Dallas, Texas
Gas Migration
One Fatality and
Three Injuries
February 23, 2018

- February 21, 2018 – Day 1
  - House 3527 has an incident at 5:49 a.m.
  - Homeowner heard a popping noise in the attic where the heater unit is located. He investigated and found the steel cover to the furnace not on the unit.
  - When the cover was reinstalled, the furnace operated the pilot-light igniter, and an explosion occurred throwing him backwards. He never smelled any gas odor.
  - Arson investigators responded and determined the cause as “undetermined”.
  - Gas company was also on site but not allowed to test service due to structure damage.
  - Ground saturated from exceptionally heavy rains

- February 22, 2018 – Day 2
  - House 3515 has an incident at 10:21 a.m.
  - Homeowner was alone and began to boil some water when the flames acted erratically and began to grow out of control and engulfed him.
  - Fire traveled to attic causing additional damage.
  - Arson investigators interviewed the witness and determined that it was an appliance issue.
  - No gas odor detected by resident
  - Rain continuing

- February 23, 2018 – Day 3
  - House 3534 has an incident at 6:38 a.m., with a fatality and 3 injured, 1 released
  - Lived in home one month after full renovation. Including new gas and sewer service lines to alley.
  - Homeowner head a loud pop in kitchen around 11 p.m. but found no source.
  - No gas smell prior to explosion
  - TX-RRC, NTSB and PHMSA launched to investigate.

Leak surveys were performed after each explosion, with RMLD and CGI.

Pressure testing of mains and services with air will establish the integrity of the distribution piping, or not. Also, customer piping is often tested, but piping can be damaged during fires and explosions.

- Develop a pressure test protocol
  - Where to cut and cap main and services
  - Maximum test pressure and duration
  - If a leak is identified, then flow test to determine the size of the failure(s)
  - Large sections that fail test will need to be broken up

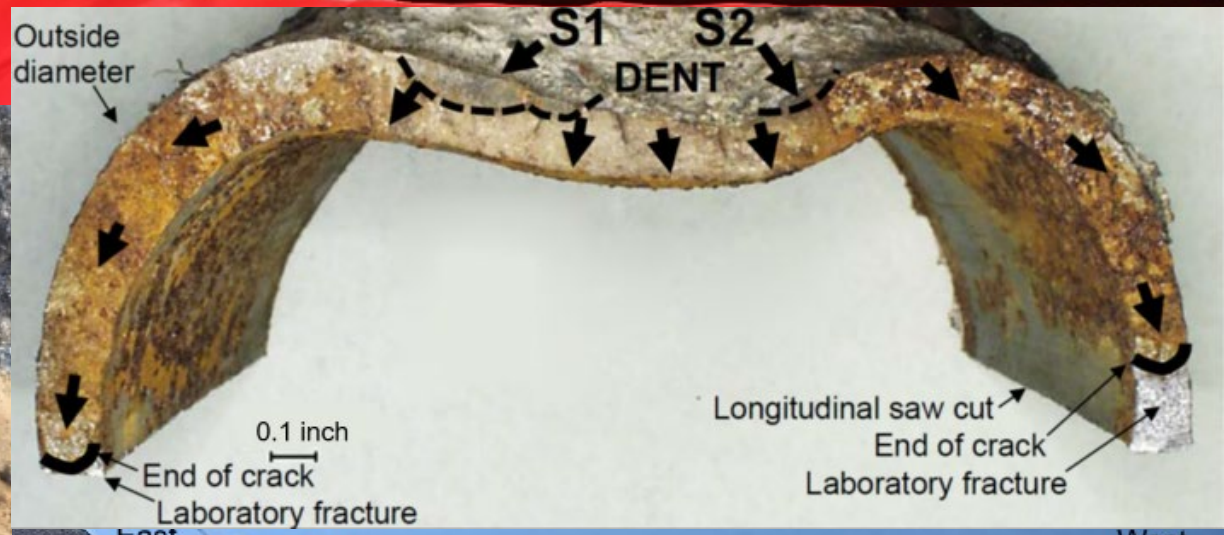
Mains and services capped and ready for pressure testing.

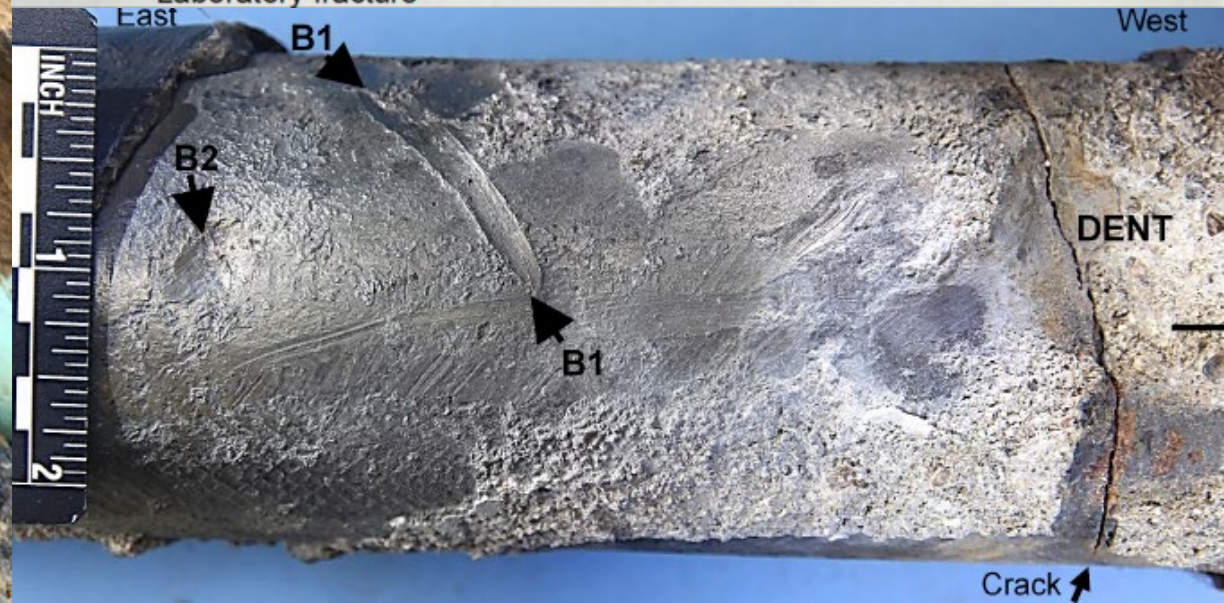
Leaks at service tee and stopcock. Some leaks will cause test pressure failures but are not hazardous. The flow rate will be inadequate to migrate any distance. Flow rate testing pipelines that fail pressure tests should be performed prior to exposing buried leaks.

During excavation pay close attention to what is being dug up. Evidence can be anywhere. Sand bedding for sewer line was conduit for gas migration. Test and document to confirm theory. CGI shows 35% LEL, 9 days after the gas was shut-off.

Evidence can be anywhere. Soil will discolor from the release of natural gas, dry out and scrub odorant. A dated coke bottle found next to main failure. Date corresponds to sewer installation.

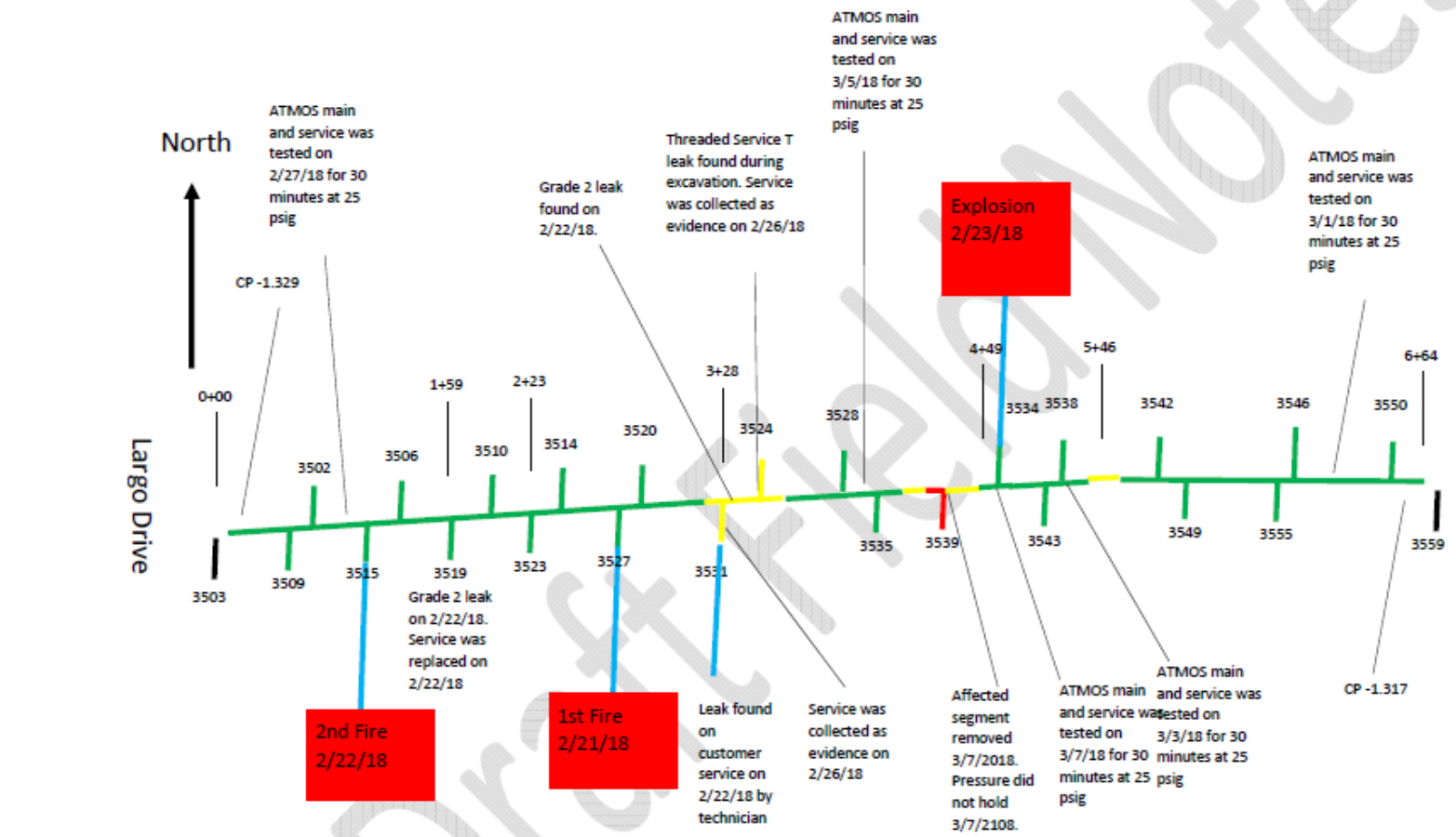
Source of the gas was identified at a location were a sewer main was installed in 1995, with only 2-inches of clearance. The line was dented and gouged with excavation equipment and failed 23 years later as a circumferential crack.





Document the details as it paints a picture. 664 feet of pipe tested with multiple leaks identified. Only one was large enough to result in the migration.

Overview of gas main and service in alley between Espanola and Durango Updated March 7, 2018



Green main segments passed pressure test

Red main segment has not held pressure.

Blue - Customer Owned services

Yellow—not pressure tested and cut out

4 pieces of evidence collected on 2/26/18:

Main/ tap and service to 3531 Durango;

Leaking Main/tap and Service to 3524 Espanola;

36"of main between both services.

2 pieces of evidence collected on 3/5/18:

Segment of Main:

(1) Between 3539 & 3535 Durango

(1) Between 3539 Durango & 3534 Espanola

11 pieces of evidence collected on 3/5/18:

3534 Espanola Service Line

3534 Espanola Segment E3

3534 Espanola Segment W4

3534 Espanola Segment W5

3534 Espanola Riser

3534 Espanola ABN Service South

3534 Espanola ABN Service North

3539 Durango Segment 1 (failed piping)

3539 Durango Segment 3

3539 Durango Segment 4

3539 Durango Segment 2

Be safe while working, What is wrong with this picture. A pressure test cap will be welded on for pressure testing in a few minutes. A compression coupling can be seen by support block.

Questions

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