INGAA R&D Focus
&
Insights

2014 PHMSA R&D Workshop

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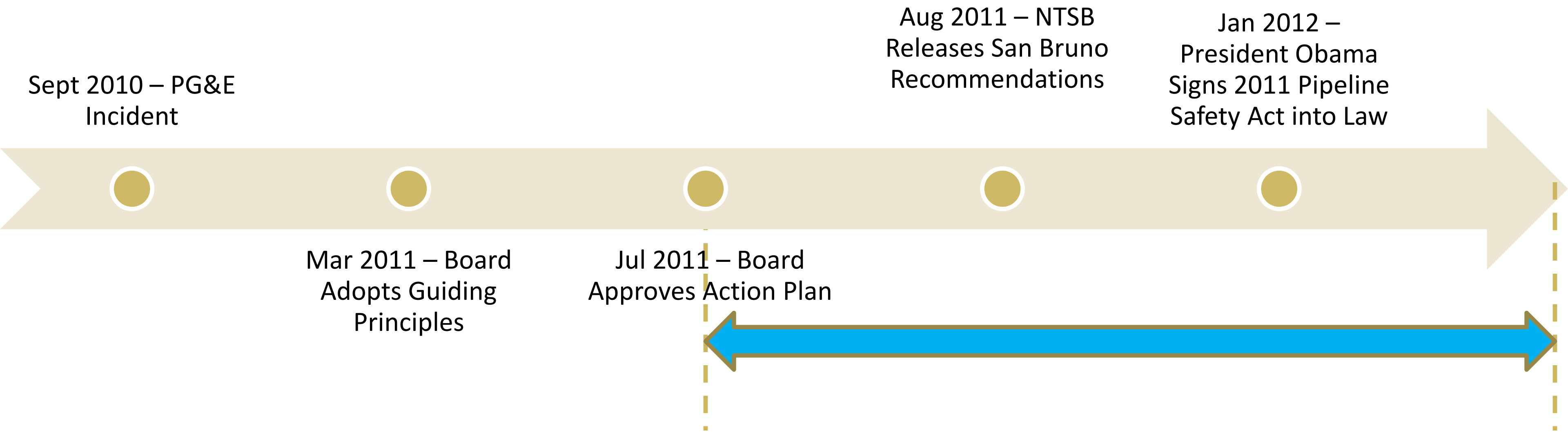
Guiding Principles

Action Plan

1. **Apply Risk Management beyond High Consequence Areas (HCAs)**
2. Raise the Standards for Corrosion Anomaly Management
3. **Demonstrate Fitness for Service on Pre-Regulation Pipelines**
4. **Shorten Pipeline Isolation and Response Time to 1 Hour**
5. Improve Integrity Management Communication and Data
6. Implement the Pipelines and Informed Planning Alliance (PIPA) Guidance
7. Evaluate, Refine and Improve Threat Assessment and Mitigation
8. **Implement Management Systems across INGAA Members**
9. Provide Forums for Stakeholder Engagement and Emergency Officials

Major Events & INGAA Action



- Jul 2011 – Foundation for Effective Safety Culture White Paper
- Mar 2012 – 2011 IM Status Update
- May 2012 – Fitness for Service White Paper
- Sep 2012 – IMM Update
- Oct 2012 – Safety Management Systems White Paper
- October 2012 – INGAA Technology Development White Paper
- Oct 2012 – ILI Technology Capability Workshop
- Oct 2012 – Lessons Learned Workshop
- Nov 2013 – Hydrotest Report
- Dec 2013 – Lessons Learned Workshop
- Dec 2013 – Kiefner Susceptibility Report
- Jan 2014 – Aligned INGAA Metrics
- Feb 2014 – ER Survey

Desired Future State – Based on IMCI ITD Plan

Technology Solutions A/B/C and Z

- Technology performance specification developed
- ILI tool(s) available and capable of meeting performance specification for detecting and characterizing target defects/properties for girth welds, long seam and pipe materials
  - A/B - Seamless, DSAW, HF-ERW
  - C – LF-ERW, EFW, SSAW (susceptible seam types)
  - Z – Pipe characterization (OD, WT, Gr, LS)
- In-the-ditch NDT tools and techniques available to assess condition
- Defect modeling/assessment tools and techniques available to assess remaining strength
- Overall process validation and protocols/standard developed
- PHMSA acknowledgement/approval
- ILI vendor capacity available

Insight #1

Integrity Management and the Effects on the "Bathtub Curve"

NATIONAL PROTECTION AND PROGRAMS DIRECTORATE
OFFICE OF CYBER AND INFRASTRUCTURE ANALYSIS

National Risk Estimate: Risks to Physical Infrastructure from Aging and Failing

JULY 2014

WORKING DOCUMENT

NOT FOR FURTHER DISTRIBUTION

National Institute of Standards

8.1.2.4. "Bathtub" curve

A plot of the failure rate over time for most products yields a curve that looks like a drawing of a bathtub

If enough units from a given population are observed operating and failing over time, it is relatively easy to compute week-by-week (or month-by-month) estimates of the failure rate $h(t)$. For example, if N_{12} units survive to start the 13th month of life and r_{13} of them fail during the next month (or 720 hours) of life, then a simple empirical estimate of $h(t)$ averaged across the 13th month of life (or between 8640 hours and 9360 hours of age), is given by $(r_{13}/N_{12} \cdot 720)$. Similar estimates are discussed in detail in the section on Empirical Model Fitting.

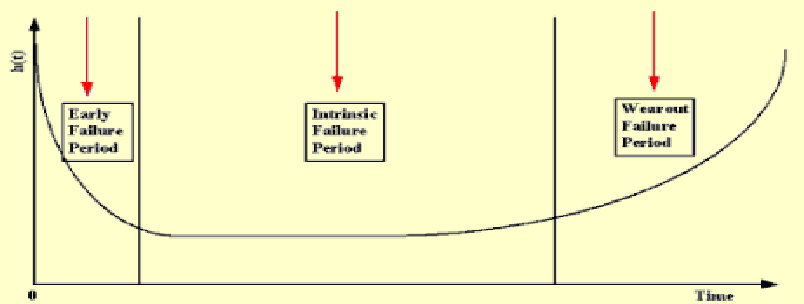
Over many years, and across a wide variety of mechanical and electronic components and systems, people have calculated empirical population failure rates as units age over time and repeatedly obtained a graph such as shown below. Because of the shape of this failure rate curve, it has become widely known as the "Bathtub" curve.

The initial region that begins at time zero when a customer first begins to use the product is characterized by a high but rapidly decreasing failure rate. This region is known as the **Early Failure Period** (also referred to as **Infant Mortality Period**, from the actuarial origins of the first bathtub curve plots). This decreasing failure rate typically lasts several weeks to a few months.

Next, the failure rate levels off and remains roughly constant for (hopefully) the majority of the useful life of the product. This long period of a level failure rate is known as the **Intrinsic Failure Period** (also called the **Stable Failure Period**) and the constant failure rate level is called the **Intrinsic Failure Rate**. Note that most systems spend most of their lifetimes operating in this flat portion of the bathtub curve

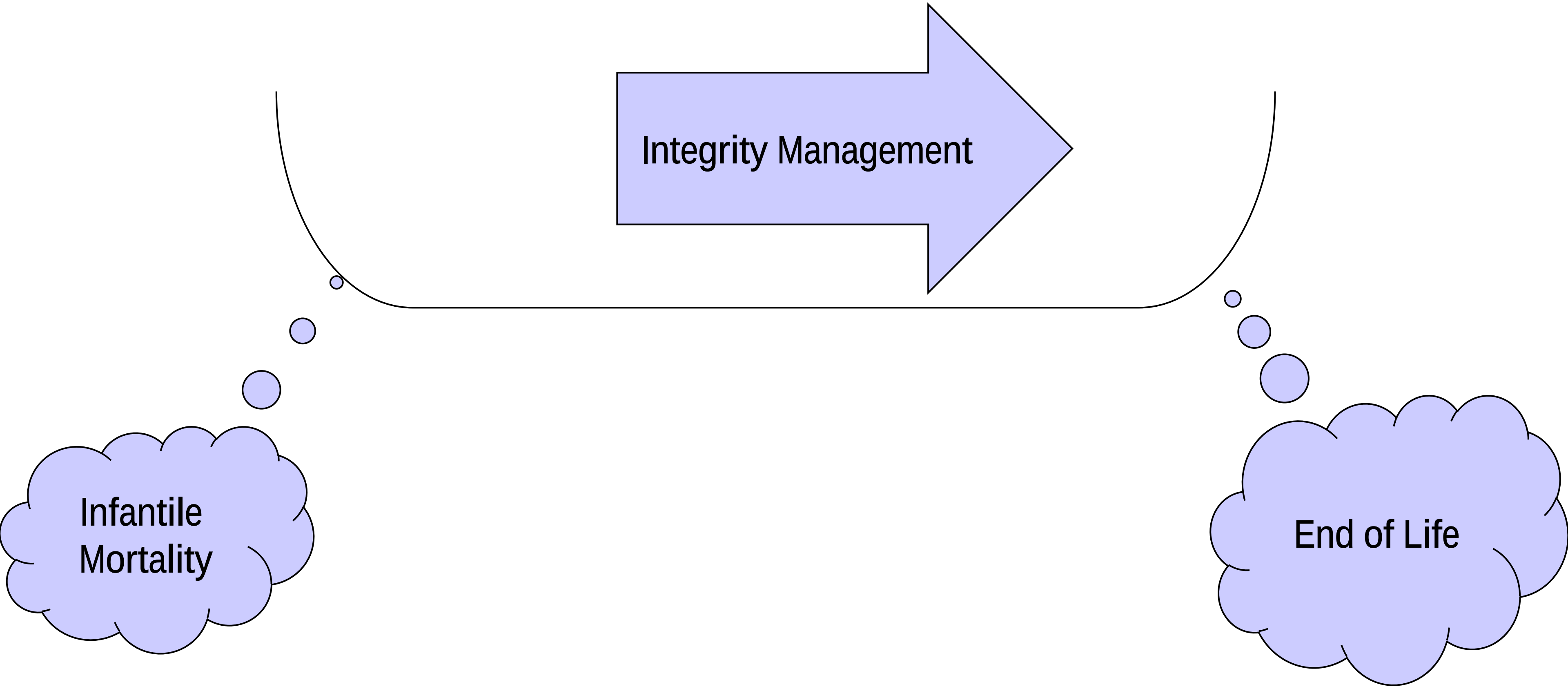
Finally, if units from the population remain in use long enough, the failure rate begins to increase as materials wear out and degradation failures occur at an ever increasing rate. This is the **Wearout Failure Period**.

The Bathtub Curve



http://itl.nist.gov/div898/handbook/apr/section1/apr124.htm

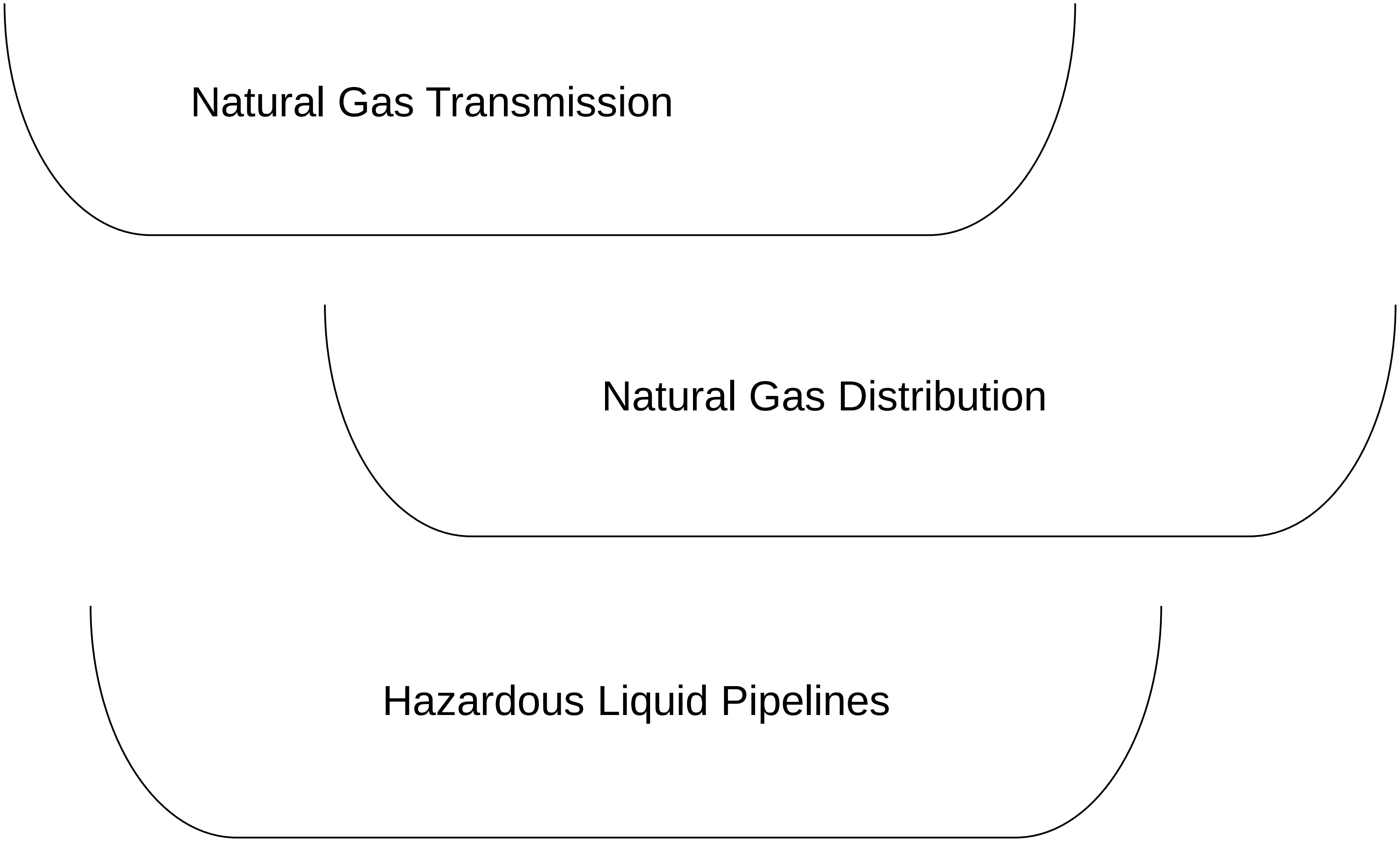
Managing Failures with Integrity Management



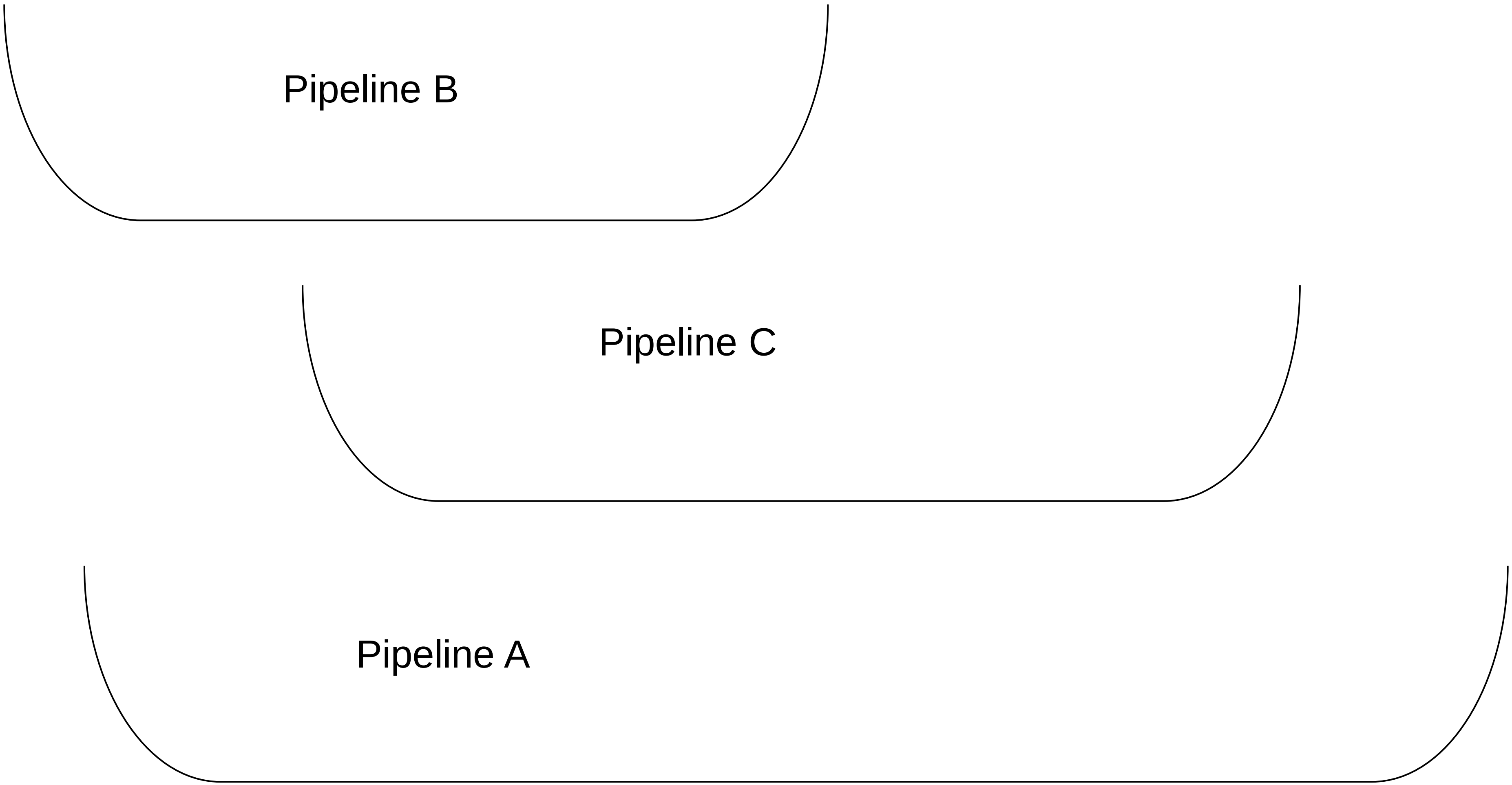
How Are These Failures Classified

- Infant Mortality
  - Construction Damage
  - Material Anomalies
- Stable (Resident) Failure Period
  - Excavation Damage
  - Natural Force (non-trending)
  - Operator Error
- Wearout Failure Period (Time Dependent)
  - Corrosion
  - Fatigue

Generic Bathtub Curves by Pipeline Type



Industry Performance is a Composite of Curves



Don’t Get Confused by the Failures

- In Service Failures
  - Incident
  - Leaks
- Inspection Detection
  - Inline Inspection
    - Corrosion
    - Mechanical Damage
    - Crack Like Features
  - Pressure Testing
  - Direct Assessment

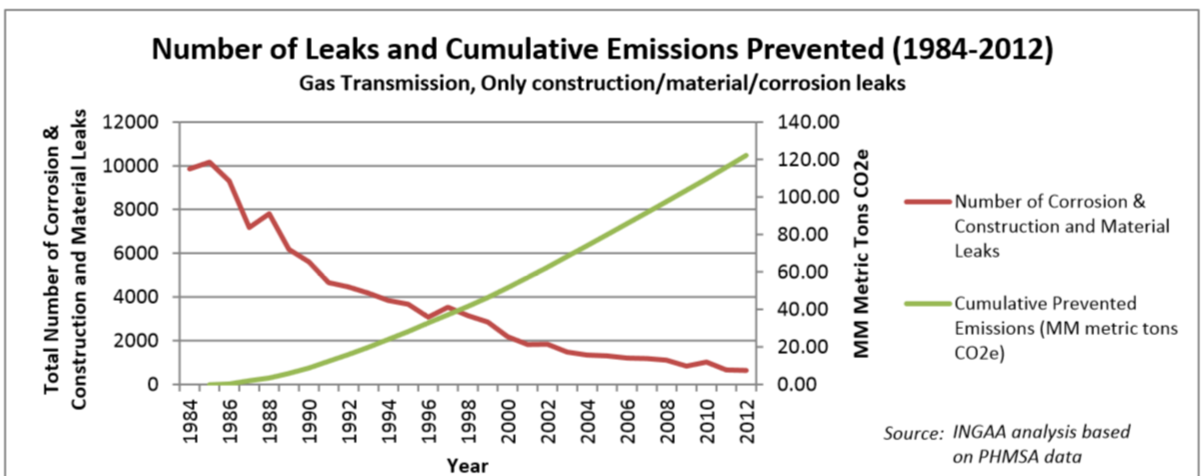
Have We Been Sucessful?

What INGAA members are doing to reduce methane releases

Reducing Pipeline Leaks

The natural gas transmission industry reduced the number of pipeline leaks by 94 percent in the past 30 years, prevented 122 million metric tons of carbon dioxide-equivalent emissions, as a result of pipeline integrity and maintenance programs and continued investment in new pipeline facilities. These prevented emissions are equivalent to removing more than 25 million passenger vehicles from the road for one year.

At this point, widespread pipeline replacement is not the answer for improving pipeline safety or reducing methane emissions from the natural gas transmission sector. This is different than the natural gas distribution sector, where some systems still include obsolete cast iron pipe. Virtually all of the material used by the natural gas transmission sector is pipeline-quality high-grade steel. Pipe replacement in the natural gas transmission sector requires—for safety and operational reasons—venting large quantities of natural gas into the atmosphere. Pipes that are unsafe must be repaired or replaced, no matter what the emissions implications. Still, policymakers should be aware that pipe repair and replacement activities on transmission systems cause significant venting emissions. They should weigh the consequences of such emissions against mandating future activities that do not add demonstrably to safety.



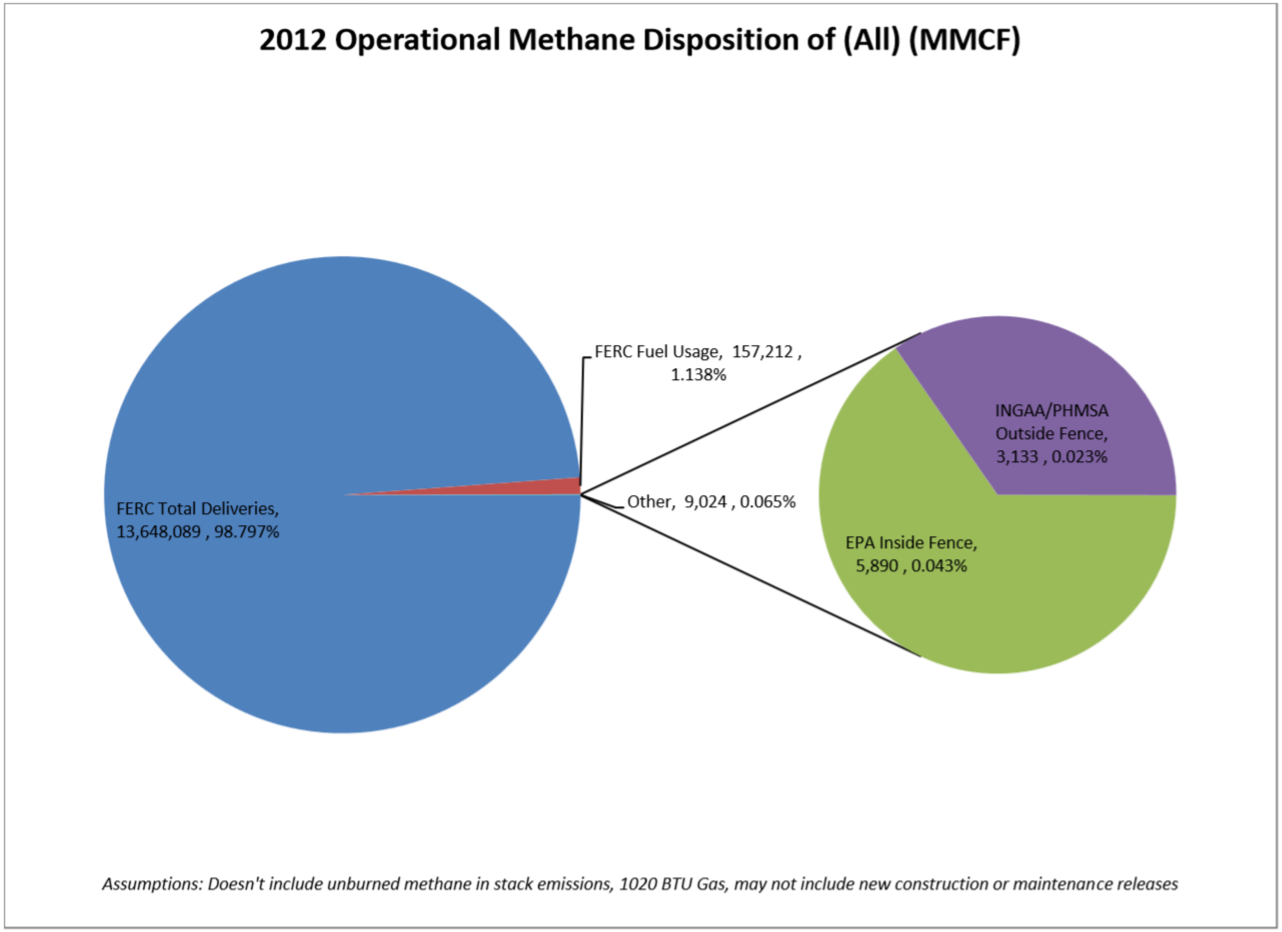
Insight #2

Methane Emissions and the Interaction with Integrity Management

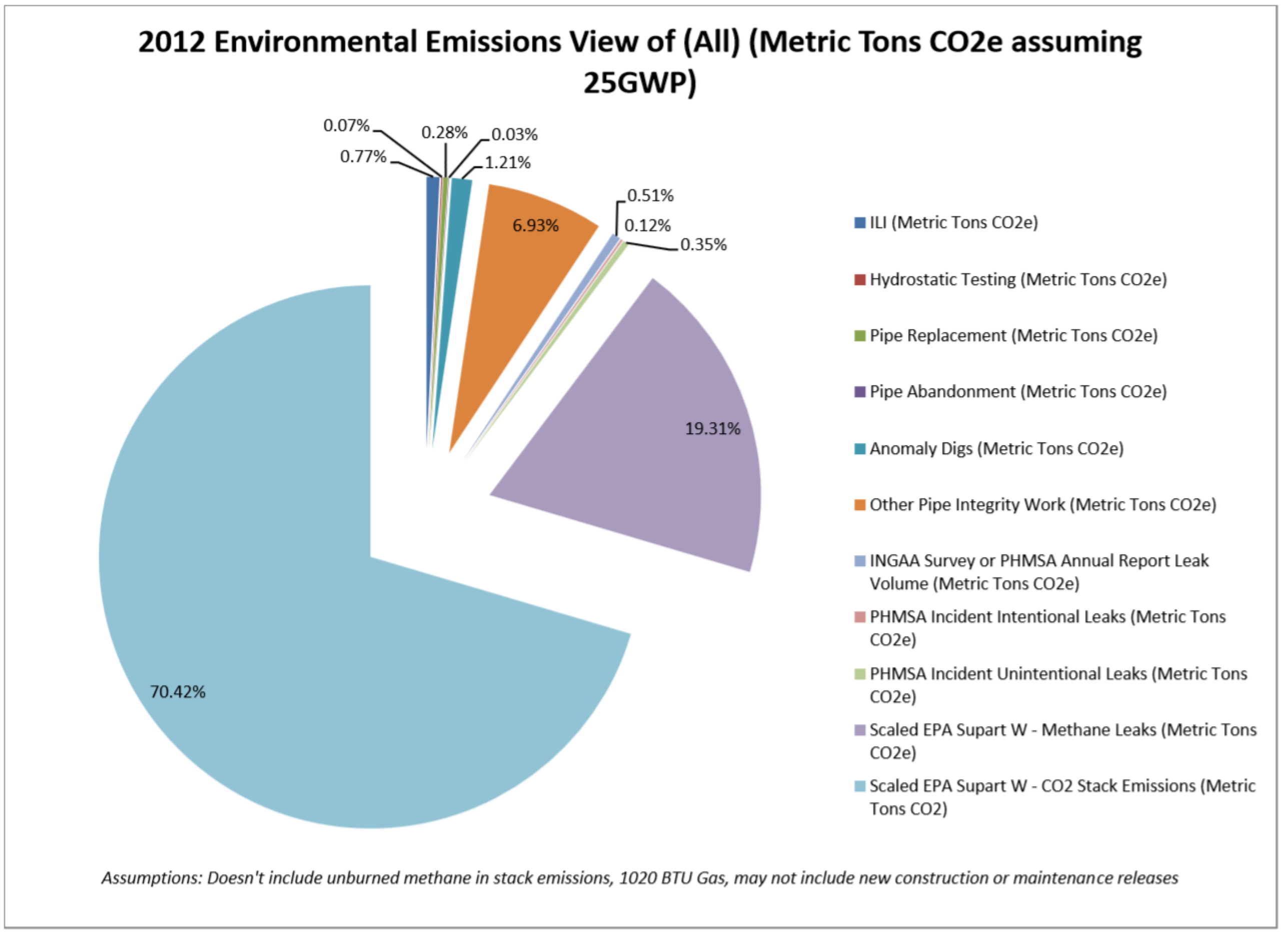
Methane Releases

- Combusted Methane
  - Compressor Engine
  - Fired Process Vessels
- Intentional Releases
  - Process Design
  - Safety Design
  - Reliability Design
- Unintentional Releases
  - Leaks
  - Incidents

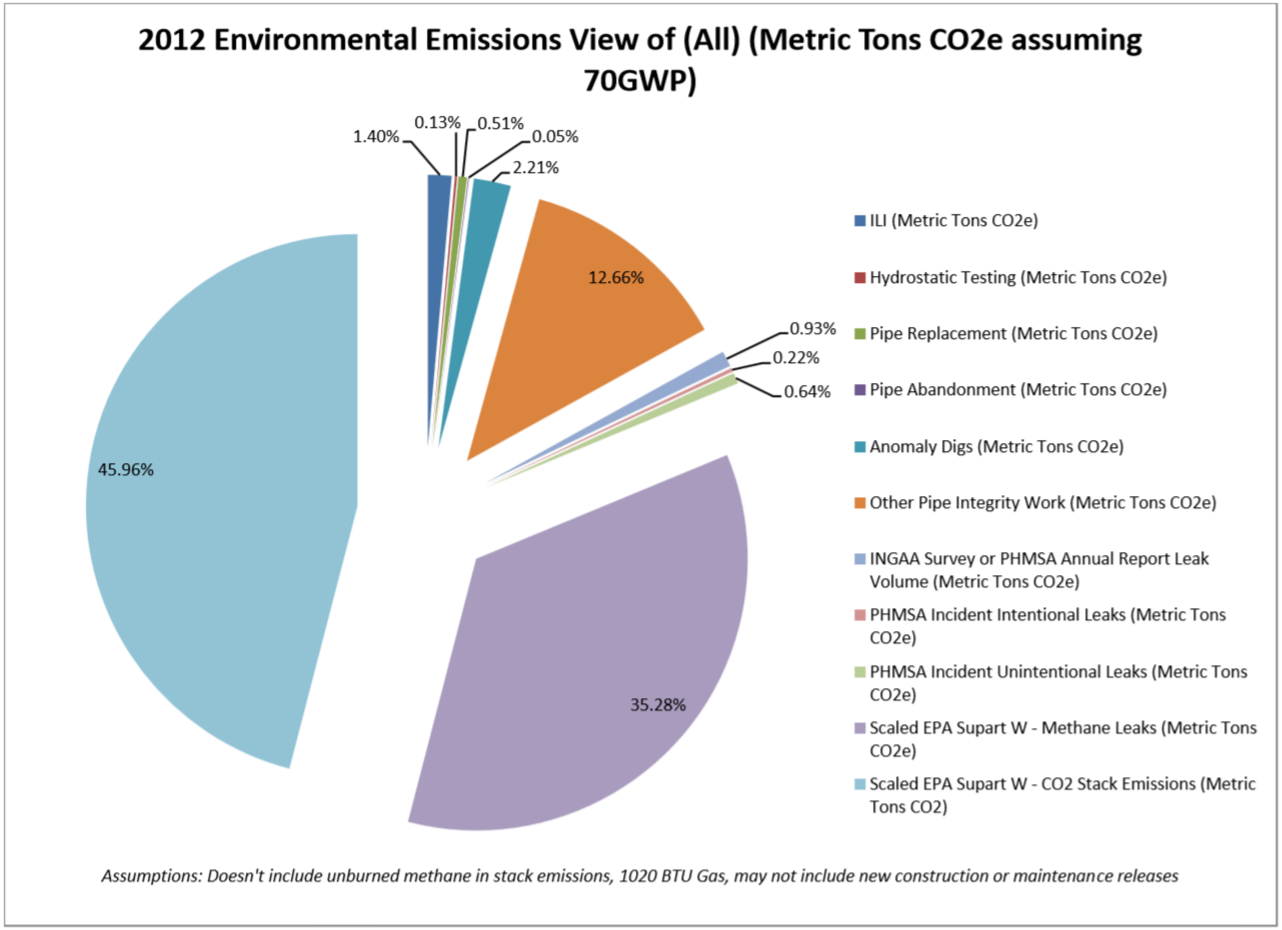
Operational View



Official UN Global Warming Potential



Rhetoric for Quick and Biased Action



Conclusion

- Focus on a Goal
- Develop a Plan to Help Achieve the Goal
- Implement this Plan
- Measure Performance of the Plan
- Utilize Discovered Insights to Adapt