Repair/Replace Considerations for Pre-Regulation Pipelines

Overview of the Research

Contract Number DTPH5614H00006

PHMSA - Office of Pipeline Safety

March 25, 2015

Agenda

- Welcome and Introductions
- Summary of Project Results
- Q&A and Discussion
- Adjourn

Meeting Information

- Wednesday, March 25, 2015
- 2PM to 3PM EDT
- Conference Call Line:
  - Phone: 877-336-1839
  - Access Code: 2781644
- LiveMeeting URL:

https://www.livemeeting.com/cc/phmsa/join?id=FSJT4J&role=attend&pw=Tp%402%25%23%3EC7

Research Team

- **Kiefner & Associates**
  - John F. Kiefner and Mark VanAuker
- **Industry Participants:**
  - David L. Johnson, Energy Transfer
  - Phillip H. DePriest, Marathon Pipe Line
  - Gary Vervake, Spectra Energy
  - Bill Taylor, Enable Midstream Partners
  - Steve Koetting, ExxonMobil Pipeline Company
  - Benny Mumme, Koch Pipeline Company
  - Bruce Paskett (retired), Northwest Natural Gas
  - Murali Nimmagadda , Baltimore Gas and Electric
  - Ed Newton, Southern California Gas Co
- **PHMSA:** Steve Nanney, Jim Merritt, and Bob Smith
  - Chris McLaren and Max Kieba - review

Repair/Replace Considerations for Pre-Regulation Pipelines

- **Project Objective:**
  - develop a standardized process for making repair/replace decisions for pre-regulation pipelines (installed prior to 1970).
  - provide a standardized method for pipeline operators to decide which of their pre-regulation pipelines can be maintained safely and which of them should be replaced because of un-repairable technical shortcomings.

Repair/Replace Considerations for Pre-Regulation Pipelines

- For more project information and final reporting, please visit https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=559
- This presentation will be posted on the above web-site.

Summary of Project Results

Repair/Replace Considerations for Pre-Regulation Pipelines

- Prepared by Kiefner & Associates
- for the Pipeline and Hazardous Materials Safety Administration
- Contract Number DTPH5614H00006
- By John F. Kiefner and Mark VanAuker

Repair/Replace Considerations for Pre-Regulation Pipelines

- **Objective**
  - The objective of this project was to develop a standardized process for making repair/replace decisions for pre-regulation pipelines to assure that they will be replaced if they deteriorate to the point that their integrity and safety can no longer be assured.

What are Pre-Regulation Pipelines?

- Pre-regulation pipelines are pipelines installed prior to November 12, 1970, when Federal pipeline safety regulations went into effect.
- Based on data submitted through natural gas transmission 2012 annual reports to the Pipeline and Hazardous Materials Safety Administration (PHMSA), 176,363 miles of the 298,422 miles of natural gas transmission and gathering pipelines in the U.S. (59%) are "pre-regulation" pipelines.
- Based on data submitted through hazardous liquid pipeline 2012 annual reports to PHMSA, 97,316 miles of the 185,922 miles of hazardous liquid pipelines in the U.S. (52%) are "pre-regulation" pipelines.

When should Pre-Regulation Pipelines be replaced?

- Older pipelines are not necessarily less safe than more modern pipelines.
- If their integrity can be maintained by appropriate and timely inspections followed by remedial responses to assure their continued safety and serviceability, they can be operated without excessive risk to the public.
- This project was conducted to develop guidelines that pipeline operators can use to determine when replacement makes more sense than continuing to do the necessary repairs to maintain the safety and serviceability of a pre-regulation pipeline.

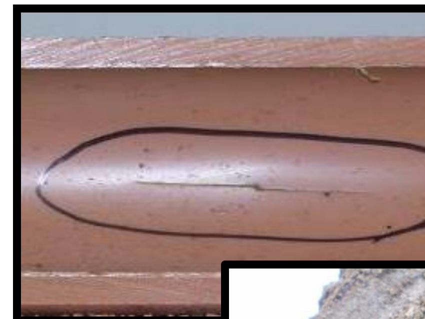
Overview of the Guidelines

- Identify and acquire the essential data that control the impact of threats to pipeline safety and integrity.
- Identify the global threats to pipeline safety and integrity (global threats are those which could affect any part of a given pipeline).
- Verify impact of global threats to pipeline safety and integrity on each pre-regulation pipeline.
- In a timely manner, mitigate global threats shown to be having an impact on pipeline safety and integrity.
- Recognize that mitigation has to be periodically repeated in most instances.
- Replace the pipeline if the operator is unwilling or unable to commit to these actions.

Mitigation (Integrity Assessment) Measures to Avoid Replacement

- Hydrostatic testing
- In-line inspection followed by in-the-ditch inspections and repairs as needed
- Direct assessment followed by in-the-ditch inspections and repairs as needed
- Other mitigative actions such as more frequent patrolling and leak surveys (applicable primarily to gas distribution mains and services)
- Calculations to predict re-assessment intervals to avoid failures of defects between assessments

Global threats to pipeline integrity that could necessitate replacement of a pipeline, if not mitigated



- External corrosion
- Internal corrosion
- Stress corrosion cracking
- Pressure-cycle induced fatigue
- Hydrogen stress cracking
- Selective seam weld corrosion
- Slow crack growth in plastic (polyethylene) pipe
- Graphitization in cast iron pipe

Localized threats that could lead to localized replacements

- Weather and outside forces
- Breakage due to frost heave (mainly an issue with cast iron pipe)

Integrity threats that usually cannot be addressed by pipeline replacement and are not considered in these guidelines

- Mechanical damage (immediate failure)
- Mechanical damage (delayed failure)
- Equipment failure
- Incorrect operations

Classification of Pipelines by Type (necessitated by the special needs and characteristics of each class)

- Hazardous liquid pipelines (crude oil, refined products, etc.)
- Natural gas transmission pipelines that are operated at stress levels of 30% of SMYS or more
- Natural gas transmission pipelines that are operated at stress levels less than 30% of SMYS
- Natural gas distribution mains and services

Hazardous Liquid Pipelines

- High consequences can be associated with spills.
- Even small leaks can have high consequences if not detected quickly.
- Susceptible to the threat of failure from pressure-cycle-induced fatigue.
- Susceptible to the threat of external corrosion.
- May be susceptible to the threat of internal corrosion.
- May be susceptible to stress corrosion cracking.
- May be susceptible to hydrogen stress cracking.
- Fracture propagation risk may be associated with highly volatile liquids (e.g., propane, anhydrous ammonia).
- Integrity assessment can be carried out by means of hydrostatic testing, in-line inspection, and/or direct assessment.
- All known methods of in-line inspection can usually be applied.

Natural Gas Pipelines High-Stress (≥ 30% of SMYS)

- High consequences can be associated with a rupture.
- Small leaks may not be hazardous.
- Susceptible to the threat of external corrosion.
- May be susceptible to the threat of internal corrosion.
- May be susceptible to stress corrosion cracking
- Not likely to be susceptible to pressure-cycle induced fatigue, but the time to failure should be calculated anyway.
- Extensive fracture propagation is possible with a rupture.
- Integrity assessment can be carried out by means of hydrostatic testing, in-line inspection, and/or direct assessment.
- Ultrasonic in-line inspection tools can be used only in special circumstances.

Natural Gas Pipelines Low-Stress (< 30% of SMYS)

- High consequences can be associated with a rupture.
- Small leaks may not be hazardous.
- Susceptible to the threat of external corrosion.
- May be susceptible to the threat of internal corrosion.
- Not likely to be susceptible to stress corrosion cracking or pressure-cycle induced fatigue but the time to failure for the latter should be calculated anyway.
- Extensive fracture propagation is not likely with a rupture.
- Integrity assessment by means of hydrostatic testing and/or in-line inspection is usually not possible.
- Integrity assessment can be carried out via direct assessment in many cases.

Natural Gas Distribution Mains and Services

- Over 50% of the mains and services in the U.S. are comprised of plastic pipe.
- Over 48% of the mains and services in the U.S. are comprised of steel pipe.
- Over 1% of the mains and services in the U.S. are comprised of cast iron pipe.
- These systems are operated at hoop stress levels less (usually a lot less) than 20% of SMYS.
- Except in unique circumstances, mains and services cannot be taken out of service.
- Integrity assessment via hydrostatic testing, in-line inspection, or direct assessment is not feasible for mains and services.

Characteristics of pre-regulation pipe that may impact integrity

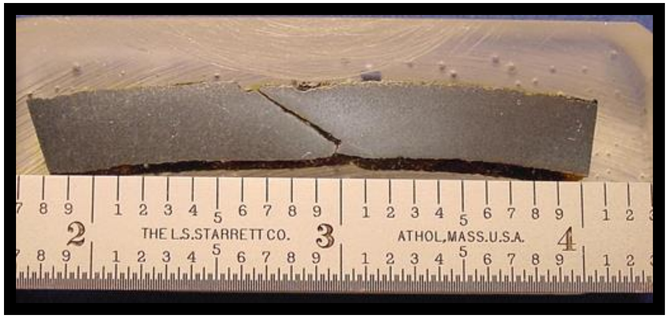
- Manufacturing process
- Seam type
- Manufacturer
- Non-existence of non-destructive inspection techniques in pipe manufacturing in the distance past
- Coating type or lack of coating in some cases
- Possibly inadequate cathodic protection early on in the life of the pipeline
- Possible overheating of pipe in early gas transmission operations
- Poor fracture toughness prior to the existence of modern steel manufacturing

Categories of Pre-Regulation Pipe or Pipelines used to establish screening formats

- **Legacy pipe** – pipe types that are no longer manufactured and that have tended to have a history of problems related to manufacturing imperfections
- **Modern pipe** – pre-regulation pipe made by current manufacturing techniques but prior to the major steel-making improvements that make possible the high-toughness, high-integrity line pipe manufactured since the early 1980s.
- **Legacy features** – types of pipe joints or methods of constructing pipelines that are now obsolete and that have sometimes caused integrity issues
- **Legacy repair methods** – types of obsolete defect-repair techniques that, themselves, have led to pipeline integrity impairment.

Legacy Pipe

- Low-frequency-welded or direct-current-welded ERW pipe
- Flash-welded pipe
- Furnace lap-welded or furnace-butt-welded pipe



- Single submerged-arc-welded pipe
- Pipe made from wrought iron, cast iron, or Bessemer steel
- Pipe made before 1942 when the pressure tests performed by the manufacturer exposed each pipe to hoop stress levels often lower than the design pressure
- Plastic (polyethylene) pipe that is susceptible to slow crack growth

Modern Pre-Regulation Pipe

- Double submerged-arc-welded pipe
- High-frequency-welded ERW pipe
- Seamless pipe

Legacy Features

- Wrinkle bends
- Miter bends
- Non-standard fittings
- Dresser couplings
- Threaded couplings
- Oxy-acetylene girth welds
- Bell-and-spigot joints

Legacy Repairs

- Patches
- Half-soles
- Puddle welds

What the operator of a pre-regulation pipeline must do to keep the pipeline in service?

- Identify the global threats to pipeline integrity.
- Acquire the essential data for conducting integrity assessments for each identified global threat.
- Calculate the times to failure for each identified threat.
- For each identified threat, carry out appropriate mitigative measures to assure the safety and integrity of the pipeline before half the time to failure for that threat has expired.
- Repeat assessments after half the calculated time to failure has expired.
- Monitor the on-going performance of the pipeline.
- Decrease the re-assessment interval to eliminate failures, or
- Replace the pipeline if failures continue to occur in spite of mitigative actions.

What operators of distribution mains and services must do

- Since the mitigative measures applicable to pipelines are generally not applicable to mains and services, distribution operators must rely on the requirements of Part 192, Subpart P (Distribution Integrity Management Program), which requires operators to develop and implement an integrity management program that includes a written integrity management plan.
- Generally, these regulations call for monitoring and inspecting of distribution systems to minimize or eliminate the risk of leaks.
- Operators should implement an effective leak management program, which may include taking additional or accelerated actions to minimize or eliminate leaks and reduce risks to the distribution system.

Essential Data

- Diameter
- Wall thickness
- Grade
- Seam-type
- MOP
- Test-pressure-to-operating-pressure ratio
- Date of most recent test
- Operating pressure spectrum
- Type of coating and level of cathodic protection
- Causes of previous in-service failures

Tools

- Suggested methods for calculating re-assessment intervals for each global threat except hydrogen stress cracking
- Suggestions for mitigating the threat of hydrogen stress cracking
- Suggested integrity assessment methods
- Suggested additional or accelerated actions for operators of gas distribution systems
- Flowcharts for each type of pipeline to guide the operator as to the necessary actions to avoid replacement

What is left for the operator to do?

- Conduct the analyses using the tools provided in the guidelines to establish the types and frequencies of integrity assessments needed to assure safety and integrity from the standpoint of each identified threat.
- Use financial analyses to establish the cost of the necessary mitigative actions.
- Compare the cost of the continuing mitigative actions to the cost of replacement.
- Factoring in the element of risk, decide whether or not to replace the pipeline.

Q&A and Discussion

Thank You

Know what's below. Call before you dig.

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