Regulatory Next Steps in Addressing Pipeline Seam Weld Challenges

2014 KCC Kansas Pipeline Safety Seminar
October 28th & 29th

Know what's **below.**
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Regulatory Next Steps in Addressing Pipeline Seam Weld Challenges

- **Introduction and History**
- **Regulatory Mandate and Recommendations**
- **Seam Study – Phase 1**
- **Seam Study – Phase 2**
- **Integrity Verification Process – Overview**
- **Regulatory Action – Status Update**

Introduction and History

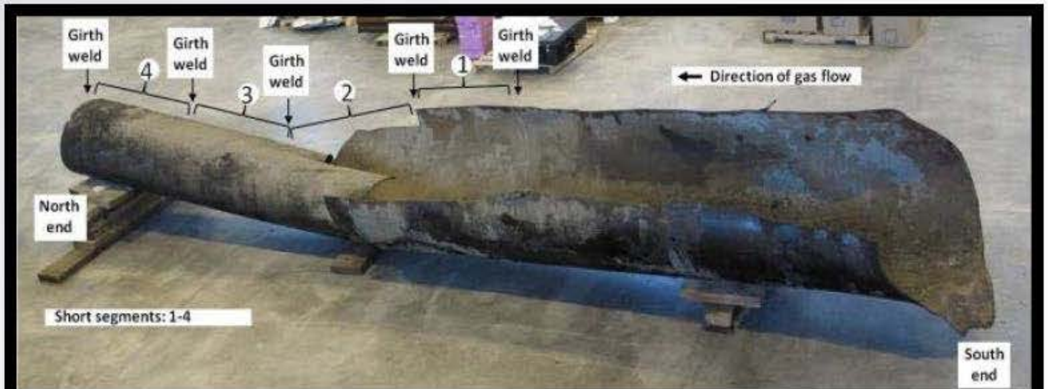
- **U.S. PHMSA - Advisory Bulletins on ERW Seam Failures**
  - **Alert Notice – ALN-88-01 and ALN-89-01**
  - Advised operators and the public on factors contributing to operational failures of pipelines constructed prior to 1970 with Electric Resistance Weld (ERW) seams
- **Liquid Propane Pipeline Rupture – Carmichael, MS**
  - November 1, 2007
  - Fracture along LF-ERW seam
  - 2 fatalities and 7 injuries

Incident #1 - Carmichael, MS

Introduction and History

- **Natural Gas Transmission Rupture – San Bruno, CA**
  - September 9, 2010
  - Failure of 30-inch diameter weld seams
  - Fracture along partial welded seam – 6 short pipe joints
  - 5 pups fabricated in 1956, did not meet pipe quality standards
  - 8 fatalities, many injured, 38 homes destroyed, 70 homes damaged

Incident #2
San Bruno, CA



Photograph of the 28-foot-long ruptured section of pipeline

U.S. Regulatory Mandate and Recommendations: *Pipeline Safety Act of 2011*

- **Pipeline Safety Act of 2011 - Section 23**
- **Verification of Records and Reporting**
  - Identify pipe segments with no records to verify Maximum Allowable Operating Pressure (MAOP) for all Gas Transmission steel pipe [Class 3, 4 and all High Consequence Areas (HCAs)]
- **Determination of MAOP**
  - Reconfirm MAOP for pipeline segments with insufficient records
- **Testing Regulations**
  - Requires conducting tests to confirm material strength of previously untested gas transmission steel pipelines in HCAs and operating pressure of +30% Specified Minimum Yield Strength (SMYS) that were not previously pressure tested

U. S. Regulatory Mandate and Recommendations: *NTSB Recommendations*

- ***NTSB P-09-01 "Comprehensive Study"*** – to identify actions that can be implemented to eliminate catastrophic longitudinal seam failures in ERW pipe
- ***NTSB P-09-02 "Implement Actions from Study Findings"***
- ***NTSB P-11-14 "Delete Grandfather Clause"*** – recommends all grandfathered pipe be pressured tested, including a "spike" test
- ***NTSB P-11-15 "Seam Stability"*** – recommends pressure test to 1.25 x MAOP before treating latent manufacturing and construction defects as "stable"
- ***NTSB P-11-17 "Piggable Lines"*** – Configure all lines to accommodate smart pigs, with priority given to older lines

U. S. Regulatory Mandate and Recommendations

- **How much pipeline mileage will these mandates and recommendations effect?**

Piggability: ILI Able vs Not Able

Part R	Total Miles	ILI Able	ILI Not Able
Class 1 - HCA	1,658	1,380	278
- non-HCA	234,851	146,035	88,816
Class 2 - HCA	1,409	1,152	257
- non-HCA	28,978	15,073	13,905
Class 3- HCA	15,850	10,469	5,381
- non-HCA	16,751	6,924	9,827
Class 4 - HCA	752	366	386
- non-HCA	209	112	97
TOTAL	**300,458**	**181,511**	**118,947**

Gas Transmission 2012 Annual Report data as of 7-1-2013

Summary of Gas Transmission (GT) Pipe

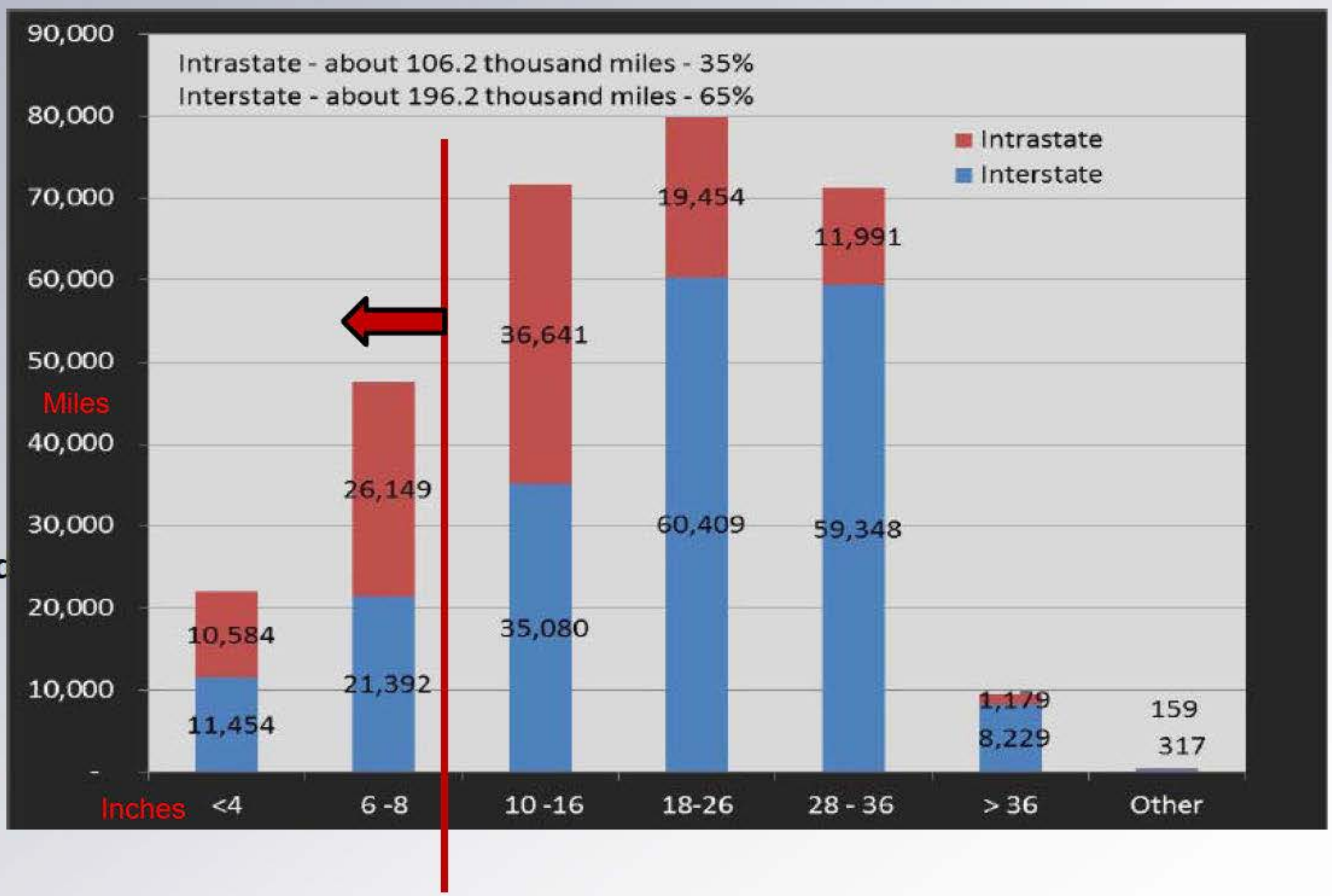
Location	Total GT Miles	% in HCA	GT HCA Miles	Non-HCA Miles
Class 1	237,756	0.7	1,660	236,096
Class 2	30,210	4.7	1,412	28,798
Class 3	32,613	48.6	15,854	16,759
Class 4	962	78.2	752	209
Total	**301,540**		**19,678**	**281,862**

Data as of 7-1-2013 from Part Q of Operator Annual Reports

Aging Infrastructure: % by Decade in USA

Decade	Hazardous Liquid		Gas Transmission		Gas Distribution Main		Gas Distribution Service	
Unknown & <1920	2%		---					
1920s	2%		2%		---		---	
1930s	3%		4%		6%		3%	
1940s	8%	56%	7%	58%	2%		2%	
1950s	20%		22%		10%	47%	8%	40%
1960s	21%		23%		17%		13%	
1970s	16%		11%		12%		14%	
1980s	9%		10%		14%		17%	
1990s	11%	44%	11%	42%	21%	53%	22%	60%
2000s	8%		10%		18%		21%	

Nominal Pipe Size



Pressure Test Range

Pressure Test Range	Total Miles	% Total
PT < 1.1 MAOP or no PT	93,817	31%
1.25 MAOP > PT ≥ 1.1 MAOP	19,131	6%
PT ≥ 1.25 MAOP	187,628	62%

Gas Transmission 2012 Operator Annual Report data as-of 7-1-2013

Seam Study

Comprehensive Study to Understand Longitudinal ERW Seam Failures

- **Research Contractor: Phase 1**
  - Battelle
- **Subcontractors: Phase 1**
  - Det Norske Veritas (DNV) & Kiefner and Associates (KAI)
- **Principle Investigators: Phase 1**
  - Bruce Young – Battelle
  - Brian Leis & Bruce Nestleroth, in conjunction with
  - John Kiefner (KAI) & John Beavers (DNV)
- **Phase 1 Completed – Jan. 2014; Phase 2 underway**

Phase 1 – Findings

- **ILI Detection & Sizing:**
  - ILI results show inconsistencies with digs & hydro test results
    - May be due to either ILI tool findings or interpretation
  - ILI tools are useful for finding & eliminating some seam defects
- **In-the-Ditch Assessment Methods**
  - No consistent standard practice
  - Can be inspector dependent
- **In-the-Ditch / ILI Improvements required for:**
  - More specific identification of anomaly type
  - Reduction of false calls
  - Improved sizing of defect depth and length for effective assessment and evaluation results

Phase 1 – Findings

- **Failure Pressure Models**
  - Should use a more representative Charpy impact toughness position relative to the bond line
  - Toughness values when unknown, need to be conservative
- **Predictive Model for Assessing Failure Stress Levels**
  - Must be based upon whether the failure is brittle or ductile, if unknown evaluate for both
  - Must use lower-bound failure stress levels based upon defect type (cold weld, hook cracks, stress corrosion cracking, etc.)

Phase 1 – Findings

- **Hydrostatic test pressures**
  - Need to be higher to be effective based upon a review of over 600 seam failures
  - Time to failure increases at an exponential rate to increased test pressure
  - Higher test pressures should mean longer interval before a retest

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

Phase 2 – Overview

1. **Improve hydrotesting protocols for ERW/FW Seams**
2. **Enhance Defect Detection and Sizing via Inspection**
3. **Defect Characterization:** Types, Sizes, & Shapes
4. **Develop & Refine Predictive Models & Quantify Growth Mechanisms**
5. **Develop Management Tools**
6. **Public Meeting/Forum**

Completed reports for Phase 1 available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=390

Integrity Verification Process (IVP)

Overview of
Basic Principles

Principle #1
Apply to Higher Risk Locations

- **High Consequence Areas (HCAs)**
- **Moderate Consequence Area (MCA):**
  - Onshore area within a potential impact circle
  - Containing one or more buildings intended for human occupancy
  - Occupied site or designated Federal interstate, expressway,
    or 4-lane highway right-of-way
  - Does not meet definition of high consequence area, as defined in § 192.903.
- **PHMSA Estimates**
  - ~ 76,000 miles HCA/MCA (out of ~ 301,000 miles)

Principle #2
Screen for Categories of Concern

- **Apply process to pipeline segments with:**
  - Grandfathered Pipe
  - Lack of Records to Substantiate MAOP
  - Lack of Adequate Pressure Test
  - Operating pressures over 72% SMYS (pre-Code)
  - History of Failures Attributable to Manufacturing & Construction Defects

Principle #3
Know & Document Pipe Material

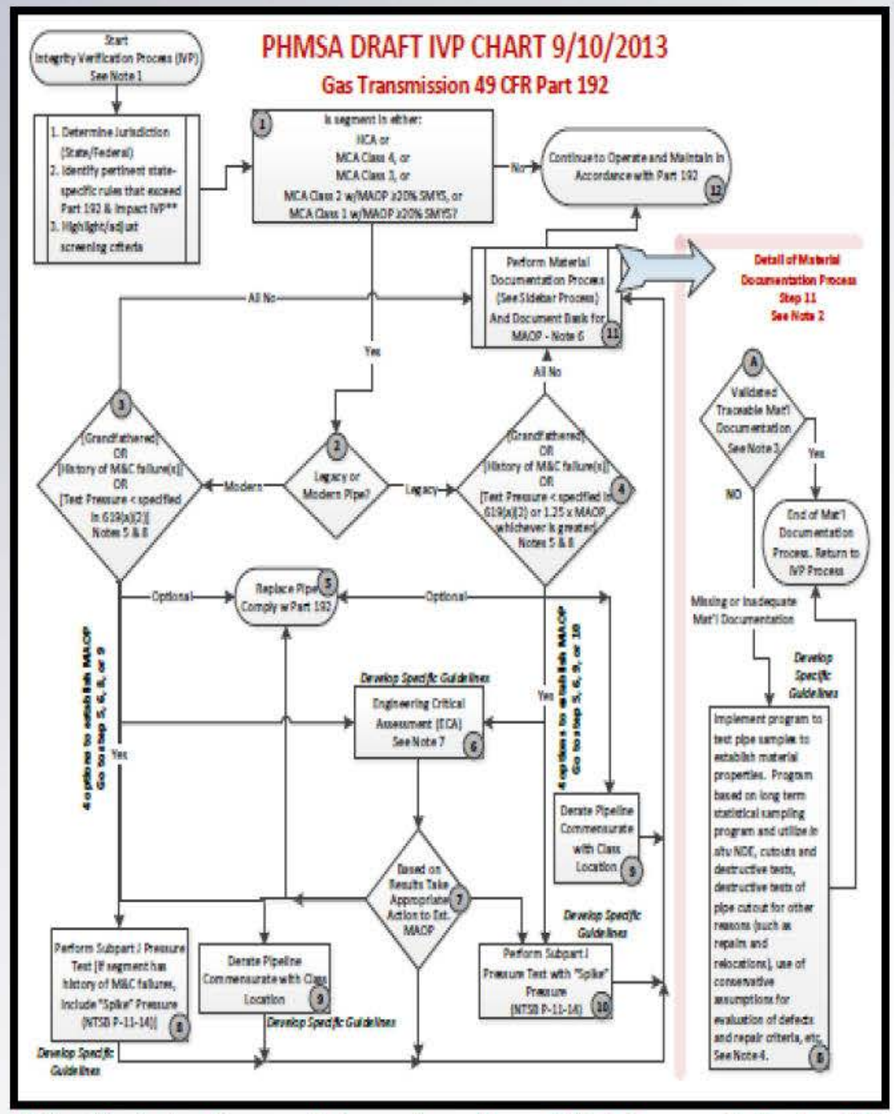
- **Inadequate Validated, Non-traceable Material Documentation, Establish Material Properties by an approved process:**
  - Cut out and Test Pipe Samples (Code approved process)
  - *In Situ* Non-Destructive Testing (if validated and if Code approved)
  - Field verification of code stamp for components such as valves, flanges, and fabrications
  - Other verifications

Principle #4
Assessments to Establish MAOP

- Allow Operator to Select Best Option to Establish MAOP
- **Candidate IVP Options for Establishing MAOP**
  - Subpart J Pressure Test with Spike Test
  - Derate Operating Pressure
  - Engineering Critical Assessment
  - Replace Pipe Segment
  - Alternative Technology or Technical Options
  - **Other options PHMSA should consider?**

Integrity Verification Process (IVP) Chart

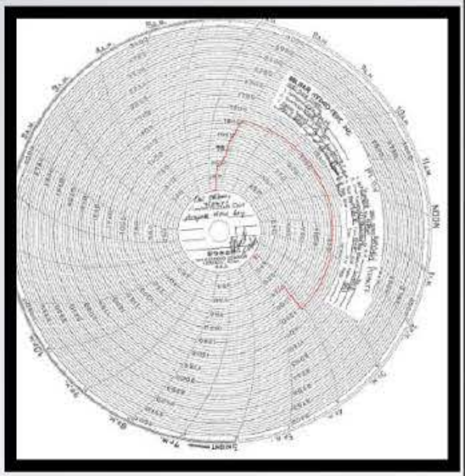
- **Applicable Segments**
  - (Steps 1, 2, 3 and 4)
- **MAOP Determination**
  Methods (Steps 5 – 10)
  - Pressure Test
  - Pressure Reduction
  - Engineering Critical Assessment (ECA)
  - Pipe Replacement
  - Pressure Reduction for Segments w/Small PIR
  - Alternative Technology
- **Materials Documentation (11)**
  - Destructive
  - Non-destructive
- **Continue Operations (12)**

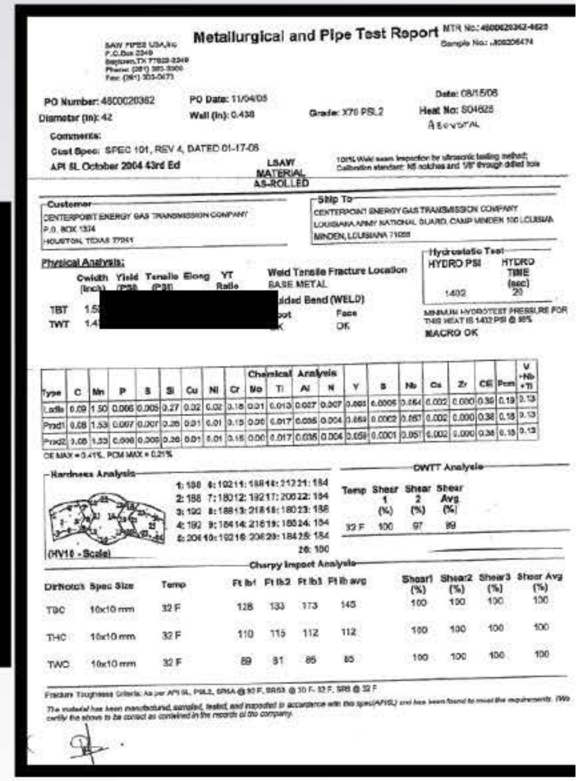


http://primis.phmsa.dot.gov/meetings/MtgHome.mtg?mtg=91

Why are pipeline material records needed?

- **To establish design and MAOP**
- **For integrity management (IM)**
- **Anomaly evaluations for safe operating pressure**
- **Record Types:**
  - Materials
  - Design
  - Construction
  - Pressure Testing
  - Corrosion Control
  - O & M –
    - IM, Surveys, Patrols, Manuals, Procedures





Metallurgical and Pipe Test Report

SAW PIPES USA,Inc
P.O.Box 2349
Baytown,TX 77522-2349
Phone: (281) 383-3300
Fax: (281) 383-0473

MTR No.: 4600020362-4625
Sample No.: J08206474

PO Number: 4600020362 PO Date: 11/04/05 Date: 08/15/06
Diameter (in): 42 Wall (in): 0.438 Grade: X70 PSL2 Heat No: S04625

Comments:
Cust Spec: SPEC 101, REV 4, DATED 01-17-06
API 5L October 2004 43rd Ed

LSAW MATERIAL AS-ROLLED

100% Weld seam inspection by ultrasonic testing method; Calibration standard: N5 notches and 1/8" through drilled hole

Customer
CENTERPOINT ENERGY GAS TRANSMISSION COMPANY
P.O. BOX 1374
HOUSTON, TEXAS 77251

Ship To
CENTERPOINT ENERGY GAS TRANSMISSION COMPANY
LOUISIANA ARMY NATIONAL GUARD, CAMP MINDEN 100 LOUISIANA
MINDEN, LOUISIANA 71055

Physical Analysis:

Cwidth (Inch) Yield (PSI) Tensile (PSI) Elong YT Ratio

TBT 1.5 [redacted]
TWT 1.4 [redacted]

Weld Tensile Fracture Location
BASE METAL
Guided Bend (WELD)
Face
OK

Hydrostatic Test

HYDRO PSI	HYDRO TIME (sec)
1402	20

MINIMUM HYDROTEST PRESSURE FOR THIS HEAT IS 1402 PSI @ 95%
MACRO OK

Chemical Analysis

Type	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Ti	Al	N	V	B	Nb	Ca	Zr	CE	Pcm	V +Nb +Ti
Ladle	0.09	1.50	0.006	0.005	0.27	0.02	0.02	0.18	0.01	0.013	0.027	0.007	0.005	0.0005	0.064	0.002	0.000	0.39	0.19	0.13
Prod1	0.08	1.53	0.007	0.007	0.26	0.01	0.01	0.15	0.00	0.017	0.035	0.004	0.059	0.0002	0.067	0.002	0.000	0.38	0.18	0.13
Prod2	0.08	1.53	0.008	0.009	0.26	0.01	0.01	0.16	0.00	0.017	0.035	0.004	0.058	0.0001	0.057	0.002	0.000	0.38	0.18	0.13

CE MAX = 0.41%, PCM MAX = 0.21%

Hardness Analysis

1: 188 6: 192 11: 188 16: 212 21: 184
2: 186 7: 180 12: 192 17: 206 22: 184
3: 192 8: 188 13: 218 18: 180 23: 186
4: 192 9: 184 14: 216 19: 180 24: 184
5: 206 10: 192 15: 206 20: 184 25: 184
26: 190

(HV10 - Scale)

DWTT Analysis

Temp	Shear 1 (%)	Shear 2 (%)	Shear Avg (%)
32 F	100	97	99

Charpy Impact Analysis

Dir/Notch	Spec Size	Temp	Ft lb1	Ft lb2	Ft lb3	Ft lb avg	Shear1 (%)	Shear2 (%)	Shear3 (%)	Shear Avg (%)
TBC	10x10 mm	32 F	128	133	173	145	100	100	100	100
THC	10x10 mm	32 F	110	115	112	112	100	100	100	100
TWC	10x10 mm	32 F	89	81	85	85	100	100	100	100

Fracture Toughness Criteria: As per API 5L, PSL2, SR5A @ 32 F, SR5B @ 32 F, SR6 @ 32 F

The material has been manufactured, sampled, tested, and inspected in accordance with the spec(API5L) and has been found to meet the requirements. (We certify the above to be correct as contained in the records of the company.

Material Documentation Plan

- **Procedures**
  - Tests for:
    - Yield strength, ultimate tensile strength, seam type, coating type and chemistry
  - Destructive Tests
    - Pipe removed from replacements and relocations
  - Destructive and/or Non-Destructive Tests
    - Direct examinations, repairs, remediation & maintenance
  - Tests used only to verify and document material grade

MAOP Determination

- **Applicable Locations**
  - Located in HCA, MCA, and meets any of the following:
    - Experienced reportable in-service incident since last pressure test due…
    - Legacy pipe or constructed with legacy construction techniques and has not had a Pressure Test (PT) of the greater of
      - 1.25 times MAOP or applicable Class location PT requirement
    - No PT records
    - MAOP established per Grandfather Clause

MAOP Determination

- **Pressure Test**
  - 1.25 or class location test factor times MAOP
  - Spike test segments w/ reportable in-service incident due to legacy pipe/construction and cracking
  - Estimate remaining life, segments w/crack defects
- **Pressure Reduction**
  - Reduce pressure by MAOP divided by class location test factor
  - Estimate remaining life, segments w/crack defects
- **Pipe Replacement**
  - Install new pipe that meets Code requirements

MAOP Determination

- **Engineering Critical Assessment (ECA)**
  - ECA analysis – for MAOP
    - Segment specific technical and material documentation issues
    - Analyze crack, metal loss, and interacting defects remaining in pipe, or could remain in the pipe, to determine MAOP
    - MAOP established
- **Alternative Technology**
  - Alternative technical evaluation process that provides a sound engineering basis for establishing MAOP

Regulatory Action – Status Update

- **Notice of Proposed Rulemaking (NPRM)**
  - Regulation drafted
  - Being routed for approval to notice to Public
- **Applicable to Gas Transmission Pipelines**
  - 49 Code of Federal Regulations Part 192

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Stay Tuned

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