Pipeline and Hazardous Materials Safety Administration

Hazardous Liquid Pipeline Integrity Verification Process (HL IVP)

Overview

Industry (API/AOPL) Briefing

November 18, 2014

811 Know what's below. Call before you dig.

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HL IVP

- **What is HL IVP**
- **Where would HL IVP be applicable**
- **Drivers -** GT Statutory Mandates and NTSB Rec.
- **Goals - Principles**
- **IVP Process**
  - IVP Chart
  - Definitions
  - MOP Determination
  - Material Documentation
- **Other Part 195 Updates**

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HL IVP

What is it HL IVP:

- Verification of MOP and material records
- Pressure testing and material verification where records do not exist
- Re-evaluation, where Risk-Based Alternative used instead of Pressure Testing
- Fatigue analysis process used for determining reassessment intervals for cracking issues
- Other Part 195 Updates

HL IVP

Where would HL IVP be applicable:

- High consequence areas (HCA);
- Rural gathering lines (195.11) that could affect an HCA;
- Could affect right-of-ways of a designated interstate, freeway, expressway, and other principal 4-lane arterial roadways;
- Highly volatile liquid (HVL) pipelines; and
- Any other non-HCA hazardous liquid pipeline with an MOP of > 20% SMYS.

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GT Drivers considered for HL Pipelines:
Pipe, MOP and Material Documentation Issues

- **PSA §23(a) 60139(d) mandate for "Testing Regulations"**
  - requires either pressure testing or an alternative equivalent means such as an ILI program for pipe not previously tested;
- **PSA §23(a) 60139(a) & (b)**
  - requires operators to self-report that they do not have records to substantiate MOP and requires a strategy for addressing and correcting non-compliances that emerge from this reporting;
- **NTSB P-11-14 "Delete Grandfather Clause"**
  - recommended grandfathered pipelines be pressure tested, including a "spike" test. (This can be applied to HL's Risk-Based Alternative" pipe.); and
- **NTSB P-11-15 "Seam Stability"**
  - recommended pressure testing to 1.25 x MOP before treating latent manufacturing and construction defects as "stable."

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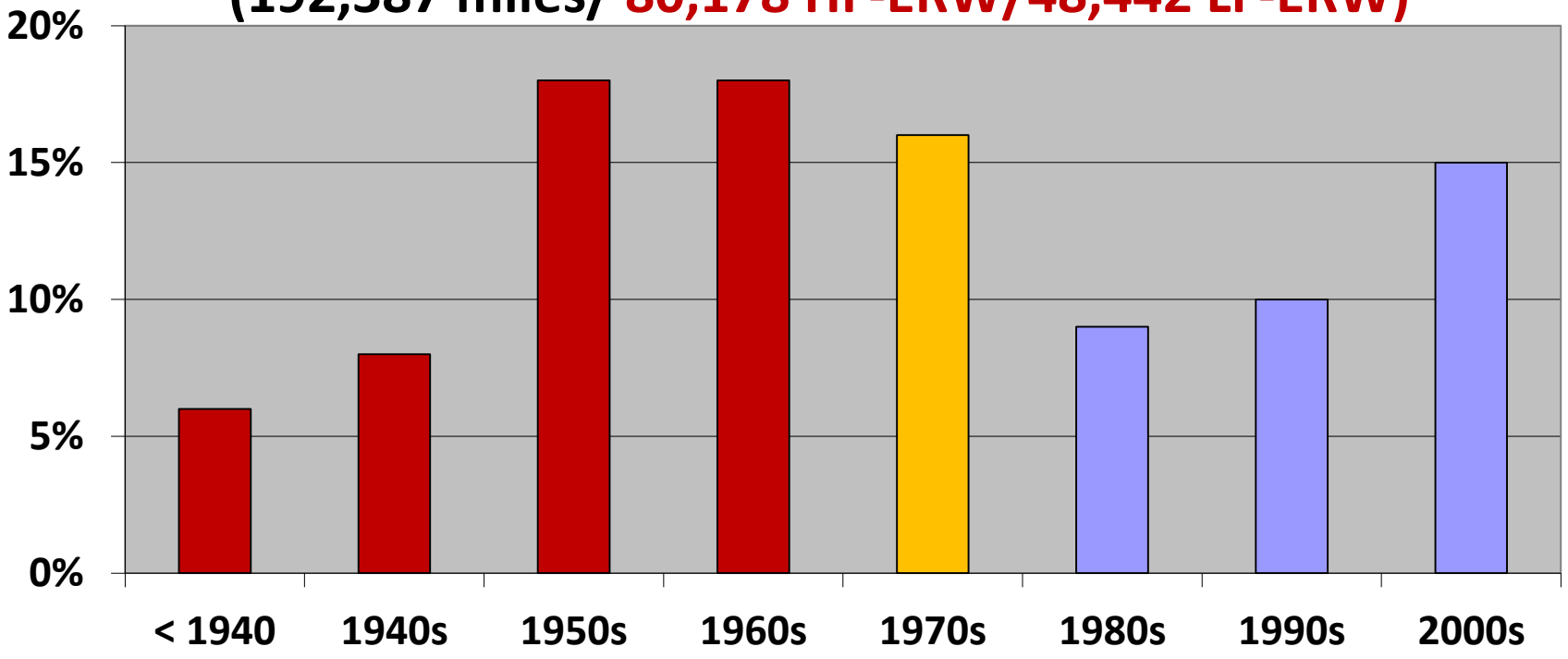
U.S. Pipeline Infrastructure

Hazardous Liquid Pipeline Vintage

50% installed prior to 1970

(192,387 miles/ 80,178 HF-ERW/48,442 LF-ERW)



PHMSA Pipeline Annual Report Data – October 31, 2014

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Basic Principles of HL IVP Approach

- **HL IVP is based on 4 principles**
  1. Apply to higher risk locations
  2. Screen segments for categories of concern
  3. Assure adequate material and documentation
  4. Perform assessments to establish MOP

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Principle # 1
Apply to Higher Risk Locations

- **High Consequence Areas (HCAs)**
- **Interstate ROW**
- **Rural Gathering (195.11) could affect an HCA**
- **HVL pipelines**
- **Non-HCA pipelines w/ MOP > 20% SMYS**

- **PHMSA Estimates ~ 182,000 miles; 95% HL mileage**

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Principle # 2
Screen for Categories of Concern

- **Apply process to pipeline segments with:**
  - Segments w/o valid pressure test (i.e., MOP established per risk-based approach § 195.303)
  - Legacy pipe w/o valid **spike** pressure test
  - History of Failures Attributable to M&C Defects
  - Lack of Records to Substantiate MOP

Principle # 3
Know & Document Pipe Material

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

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Principle # 4
Assessments to Establish MOP

- **Allow Operator to Select Best Option to Establish MOP**
- **Candidate IVP Options for Establishing MOP**
  - Pressure Test (with Spike Test for Legacy Pipe or pipe with M&C failure history)
  - Derate pressure
  - Engineering Critical Assessment
  - Replace
  - Alternative technology (notification to PHMSA required)
  - **Any other options to consider?**

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Draft – IVP Process Steps

- **13 Step Process Embodies These 4 Principles**
  - **Screen for High Risk Pipe** – Process Steps 1 – 2
  - **Integrity Review** – Process Steps 3 – 5
  - **Assessment/MOP Determination** – Steps 6 – 11
  - **Material Documentation Review** – Process Step 12
  - **Continue Operations –** Process Step 13

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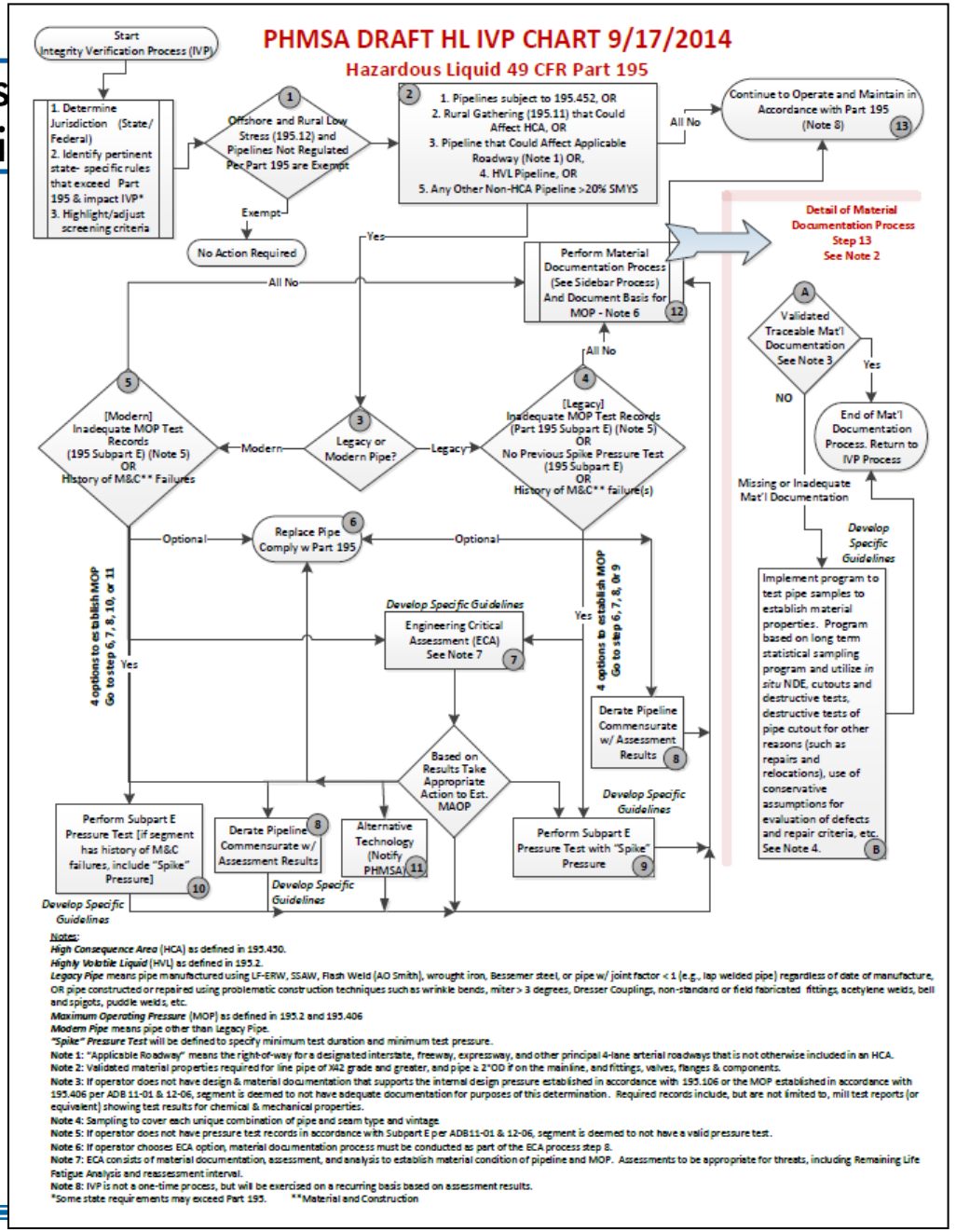
- **HL IVP Chart - Draft**
- **Applicable Segments**
  (Steps 1 and 2)
- **Integrity Review** (Steps 3 – 5)
- **Assessment/MOP Determination** (Steps 6 – 11)
  - Pressure Test
  - Pressure Reduction
  - Engineering Critical Assessment
  - Pipe Replacement
  - Alternative Technology
- **Materials Documentation**(12)
  - Destructive
  - Non-destructive
- **Continue Operations** (13)



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Part 195 Code Requirements - MOP

- **Code - Liquid Pipeline**
  - **MOP Determination**
    - 195.106 – Design Pressure
    - 195.406 - MOP
    - Subpart E – Pressure Test
      - 195.300 thru 195.310
  - **Material Determination**
    - 195 Subpart C – Design
    - 195.106 – Yield Strength, Wall thickness, & Joint factor
    - 195.112 & 114 – Pipe Qual.

MOP Verification

Definitions

- **Legacy Pipe**
  - LF-ERW, DC-ERW, SSAW, Flash Weld (AO Smith), wrought iron, Bessemer Steel, or pipe w/ joint factor <1 (e.g., lap welded pipe)
- **Modern Pipe**
  - Pipe not manufactured with any techniques listed under Legacy Pipe
- **Spike Hydrostatic Pressure Test**
  - Minimum pressure and duration
- **Legacy construction techniques**
  - Usage of any historic, now-abandoned, construction practice to construct or repair pipe segments, including wrinkle bends, miter > 3 degrees, Dresser Couplings, non-standard fittings, arc welds, oxyacetylene welds, bell spigots, puddle weld repairs, etc.

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Consideration of State-Specific Requirements

1. **Determine Jurisdiction (State/Federal)**
2. **Identify State-Specific Rules**
3. **Adjust Screening Criteria Accordingly**

- ****Some states have requirements that exceed federal regulations, e.g.,**
- Process must account for those differences

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Draft Process Steps 1 and 2 Risk-based Screening

- **Screening criteria based on location**
  - Offshore and rural low stress lines are exempt
- **Screening criteria based on operational risk**
  - High Consequence Areas – ~ 83,000 miles
  - HL pipeline (Onshore HL = ~ 182,000 miles)
  - Segment ≤ 20% SMYS - ~ 2,000 miles)
- **PHMSA High End Estimate ~ 182,000 miles; ~ 95% HL**

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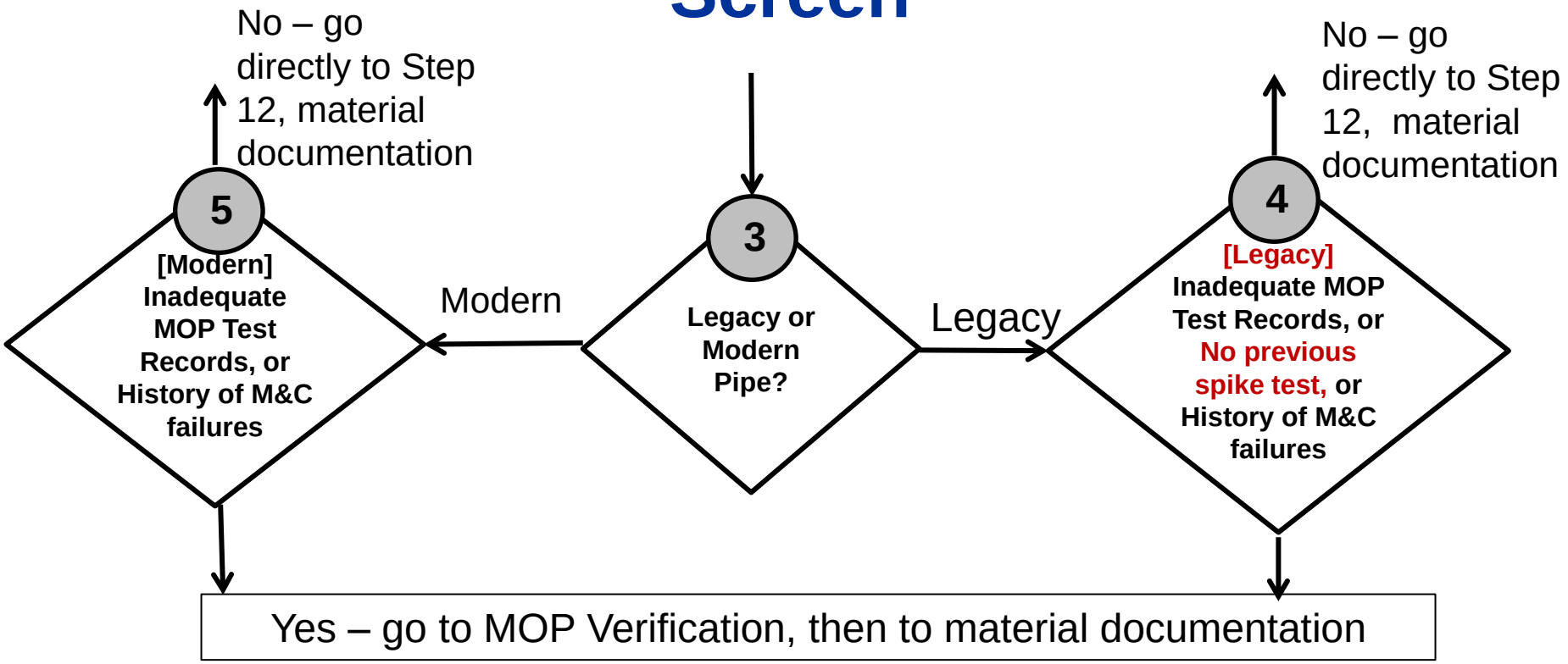
Draft - Process Steps 3 - 5
Inadequate Records and Failure History Screen



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Draft - Process Steps 3-5
Mileage that would Require MOP Verification

- HL operators did not have to report grandfathered pipe or inadequate records
- 97,050 miles pre-1970 or unknown decade of installation
- 1,054 miles of Low Frequency pipe installed after 1970
- **~ 98,104 Miles high end Est. for MOP Verification (roughly half the miles that passed initial screen)**

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Draft - Process Steps 6 through 11 MOP Determination Methods

- **Approaches based on case-specific considerations:**
  - Method 1: Pressure Test (PT)
  - Method 2: Pressure Reduction
  - Method 3: Engineering Critical Assessment (ECA)
  - Method 4: Pipe Replacement
  - Method 5: Alternative Technology
  - Method 6: **Other Methods to Consider?**

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MOP Determination Methods

- **Method 1: Pressure Test**
  - 1.25 test factor times MOP
  - Spike test segments w/ reportable in-service incident due to legacy pipe/construction, SSC, SSC, etc.
  - Estimate remaining life, segments w/crack defects
- **Method 2: Pressure Reduction**
  - Reduce pressure by MOP divided by 1.25
  - Estimate remaining life, segments w/crack defects

MOP Determination Methods

- **Method 3: Engineering Critical Assessment (ECA)**
  - **ECA analysis** - MOP based upon lowest predicted failure pressure (PFP)
    - Segment specific technical and material documentation issues
    - Analyze crack, metal loss, and interacting defects remaining in the pipe, or could remain in the pipe, to determine PFP
    - MOP established at the lowest PFP divided by a safety factor
  - **In-Line Tool Inspections** - for threats would be main inspection tools for ECA

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MOP Determination Methods

- **Method 4: Pipe Replacement**
- **Method 5: Alternative Technology**
  - May use an alternative technical evaluation process that provides a sound engineering basis for establishing MOP.
  - Notify PHMSA at least 90 or 180 days in advance of use
    - Notification must include details
    - No objection from PHMSA
- **Method 6: Other Methods to Consider?**

MOP Determination Methods

- **Fracture mechanics modeling for failure stress and cyclic fatigue crack growth analysis**
  - Contains/susceptible to cracks or crack-like defects
  - Fatigue analysis techniques
  - Analyze microstructure(ductile/brittle or both), location and type of defect, and operating conditions/pressure cycling
  - 2nd re-evaluation before **XX%** of the remaining life has expired, but within **XX** years
  - Results confirmed by an independent expert ?

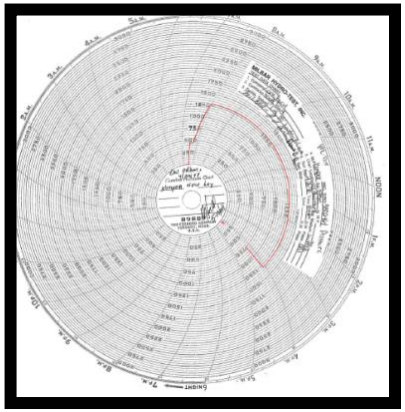
MOP Determination – Timing?

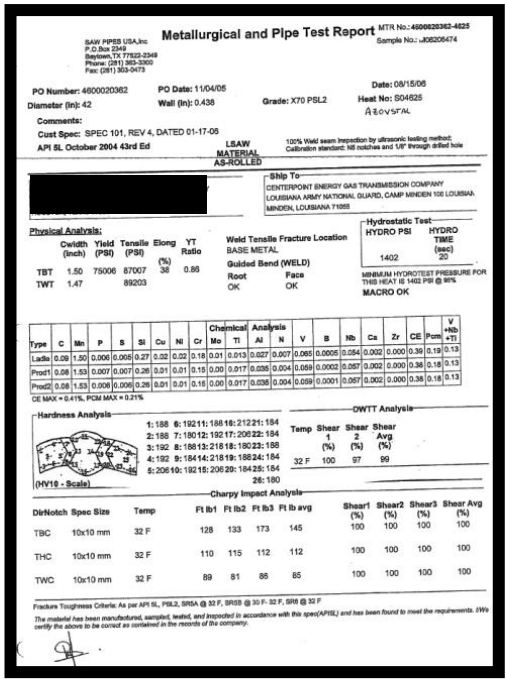
- **MOP Documentation Timing:**
  - require that existing pipeline segments in high consequence areas be assessed within XX years and reassessments every XX years thereafter
  - **Any suggestions?**

Material Documentation

Why are material records needed?

- **To establish design and maximum operating pressures (MOP)**
- **For integrity management (IM)**
- **Anomaly evaluations for safe operating pressure**





Metallurgical and Pipe Test Report

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

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	1.50	75006	87007	38	0.86
TWT	1.47		89203		

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

Hydrostatic Test: HYDRO PSI 1402, HYDRO TIME (sec) 20
MINIMUM HYDROTEST PRESSURE FOR THIS HEAT IS 1402 PSI @ 95%
MACRO OK

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	0.065	0.0005	0.054	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	0.057	0.002	0.000	0.38	0.18	0.13
Prod2	0.08	1.53	0.008	0.006	0.26	0.01	0.01	0.15	0.00	0.017	0.035	0.004	0.059	0.0001	0.057	0.002	0.000	0.38	0.18	0.13

CE MAX = 0.41%, PCM MAX = 0.21%

Hardness Analysis (HV10 - Scale)

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

DWTT Analysis

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

Charpy Impact Analysis

DirNotch	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	86	85	100	100	100	100

Fracture Toughness Criteria: As per API 5L, PSL2, SRSA @ 32 F, SRSB @ 30 F- 32 F, SRB @ 32 F

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

Material Records

- **Materials manufactured in accordance:**
  - DOT referenced standards or other applicable standards
- **Able to maintain structural integrity of the pipeline:**
  - Operating pressure, temperature, and environmental conditions including outside force loads
- **Pipe Design**
  - Withstand external pressures and anticipated loads
  - Designed for service and class location
  - Must verify: diameter, wall thickness, grade and seam type
- **Integrity Management (IM)**
  - Predicted failure pressure of defects

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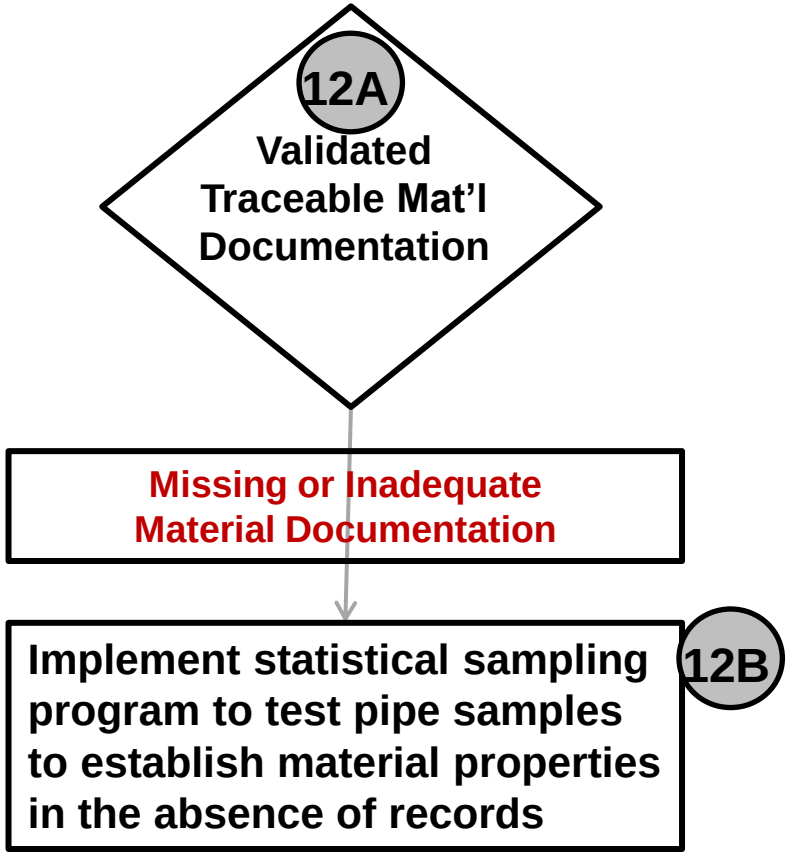
Draft - Process Step 12
Material Documentation

1. **Material Documentation also Required for Pipe, Valves, Flanges, Fittings, & Components**
2. **Validated material properties required for X-42 and greater & pipe ≥ 2-inch OD, if on mainline**



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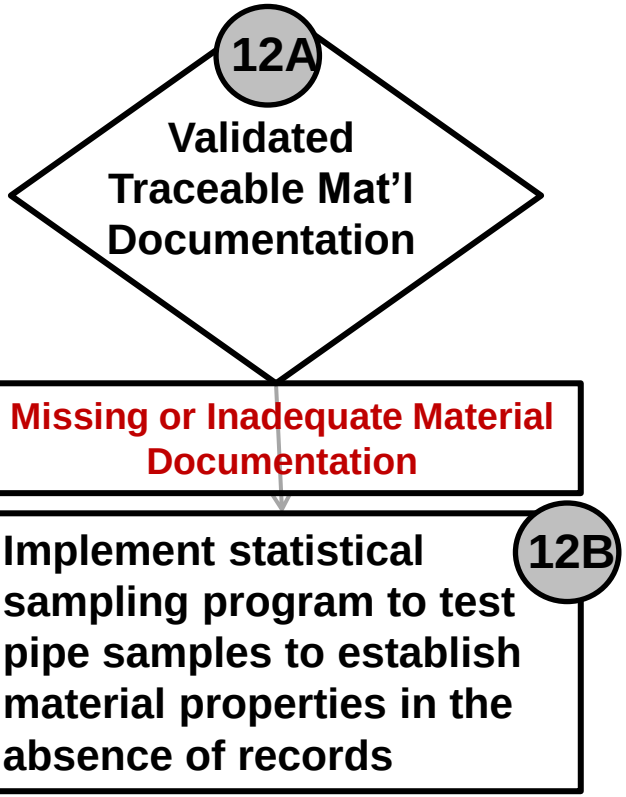
Draft - Process Step 12
Material Documentation (cont.)

3. Valves and Components (ANSI Rating)
4. Cutouts each XX joints or XX miles
5. May use *in situ* NDE, if validated
6. May not be required for some short segments
7. Each Unique Combination of Pipe Type, Seam, Vintage



Specific Guidelines & Criteria

- **IVP chart is high level concept**
- **Details and specifications to be developed**
- **For example:**
  - Spike pressure test specs (pressure, hold time, etc.)
  - De-rate criteria (amount of MOP reduction)
  - ILI program requirements and specifications
  - Material verification specs (# of cutouts, etc.)

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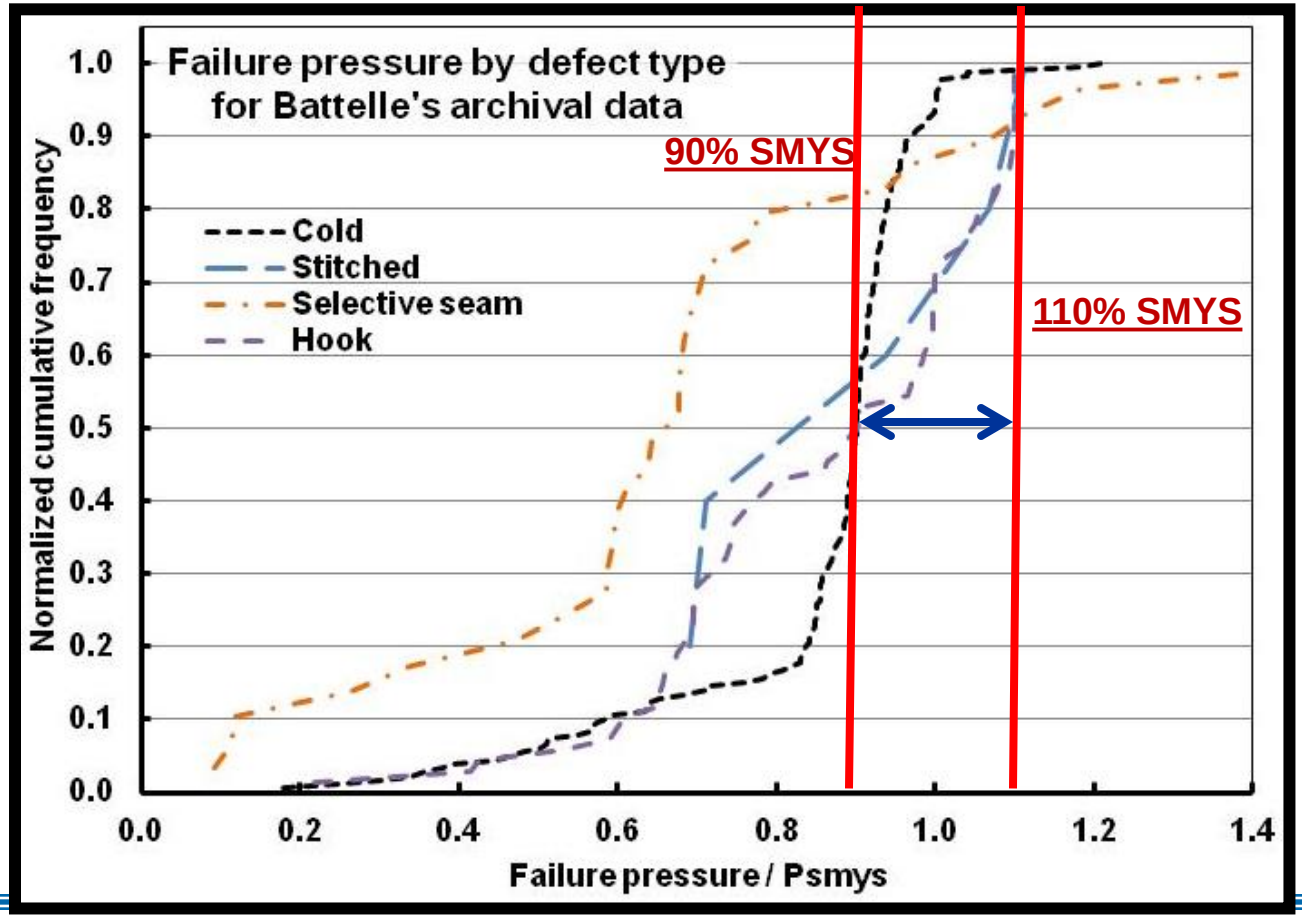
Pipe and Seam Cracking

Long Seam ERW Failures Chart



What should be considered for spike pressure test for cracking issues?

- **90% SMYS**
- **100% SMYS**
- **105% SMYS**
- **110% SMYS**

or

- **X times MOP**

Information from PHMSA Long Seam ERW R&D Program – over 600 failures

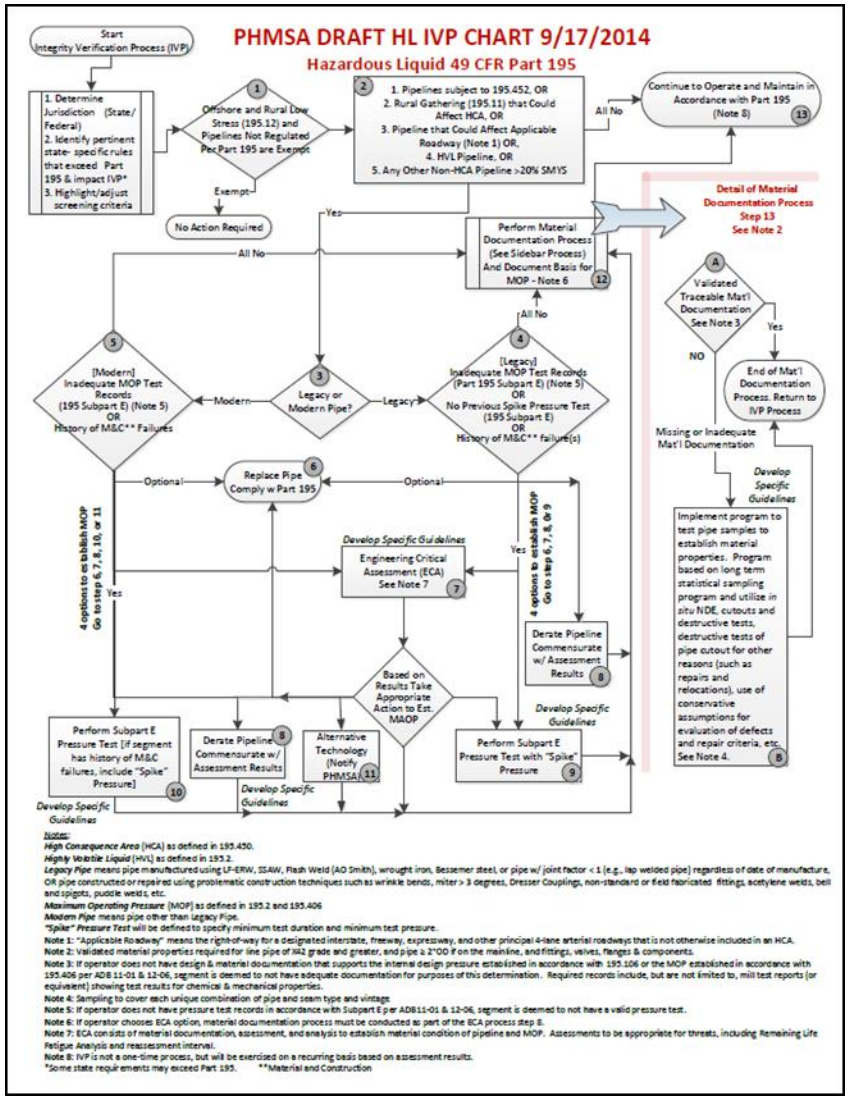
Other Part 195 Updates

- **External Corrosion Assessment and Remediation**
  - Usage of close interval surveys to find loss of cathodic protection and ineffective coatings
  - AC/DC interference surveys in high voltage power line routings
- **New Construction**
  - Coating assessments (DCVG) after backfill for new construction;
  - Girth weld NDE requirements for new construction (+95%)
  - CO_2 pipelines fracture mitigation plan requirements
    - address operating temperatures, pressures, product compositions, pipe grade and operating stress levels
    - Mitigation or arrest measures
- **GWUT Assessment Guidance in Part 195 Code**
  - for segments where ILI cannot be run

Other Part 195 Updates

- **Records Retention**
- **Appendix – Records for Life of Facility or X-years**
  - **Materials** – pipe, valves, fittings, flanges & components
  - **Design** – external loads and design pressures
  - **Construction** – inspection, welding procedures, and NDT
  - **Pressure Testing**
  - **Corrosion Control**
  - **O & M** – measurement, patrols, surveys, repairs, manuals
    - Integrity Management
    - OQ Plans
    - Control Room Management

Questions?


PHMSA DRAFT HL IVP CHART 9/17/2014
Hazardous Liquid 49 CFR Part 195
Start Integrity Verification Process (IVP)
1. Determine Jurisdiction (State/ Federal)
2. Identify pertinent state- specific rules that exceed Part 195 & impact IVP*
3. Highlight/adjust screening criteria
1 Offshore and Rural Low Stress (195.12) and Pipelines Not Regulated Per Part 195 are Exempt
Exempt
No Action Required
2 1. Pipelines subject to 195.452, OR 2. Rural Gathering (195.11) that Could Affect HCA, OR 3. Pipeline that Could Affect Applicable Roadway (Note 1) OR, 4. HVL Pipeline, OR 5. Any Other Non-HCA Pipeline >20% SMYS
All No
Continue to Operate and Maintain in Accordance with Part 195 (Note 8) 13
Yes
Perform Material Documentation Process (See Sidebar Process) And Document Basis for MOP - Note 6 12
All No
Detail of Material Documentation Process Step 13 See Note 2
A Validated Traceable Mat'l Documentation See Note 3
Yes
NO
End of Mat'l Documentation Process. Return to IVP Process
Missing or Inadequate Mat'l Documentation
Develop Specific Guidelines
Implement program to test pipe samples to establish material properties. Program based on long term statistical sampling program and utilize in situ NDE, cutouts and destructive tests, destructive tests of pipe cutout for other reasons (such as repairs and relocations), use of conservative assumptions for evaluation of defects and repair criteria, etc. See Note 4. 8
4 [Legacy] Inadequate MOP Test Records (Part 195 Subpart E) (Note 5) OR No Previous Spike Pressure Test (195 Subpart E) OR History of M&C** failure(s)
3 Legacy or Modern Pipe?
Legacy
Modern
5 [Modern] Inadequate MOP Test Records (195 Subpart E) (Note 5) OR History of M&C** Failures
Optional
Replace Pipe Comply w Part 195 6
Optional
4 options to establish MOP Go to step 6, 7, 8, 10, or 11
Yes
Develop Specific Guidelines
Engineering Critical Assessment (ECA) See Note 7
Yes
4 options to establish MOP Go to step 6, 7, 8, or 9
Derate Pipeline Commensurate w/ Assessment Results 8
Based on Results Take Appropriate Action to Est. MAOP
Develop Specific Guidelines
Perform Subpart E Pressure Test [if segment has history of M&C failures, include "Spike" Pressure] 10
Derate Pipeline Commensurate w/ Assessment Results 8
Alternative Technology (Notify PHMSA) 11
Perform Subpart E Pressure Test with "Spike" Pressure 9
Develop Specific Guidelines
Develop Specific Guidelines
Notes:
High Consequence Area (HCA) as defined in 195.450.
Highly Volatile Liquid (HVL) as defined in 195.2.
Legacy Pipe means pipe manufactured using LF-ERW, SSAW, Flash Weld (AO Smith), wrought iron, Bessemer steel, or pipe w/ joint factor < 1 (e.g., lap welded pipe) regardless of date of manufacture, OR pipe constructed or repaired using problematic construction techniques such as wrinkle bends, miter > 3 degrees, Dresser Couplings, non-standard or field fabricated fittings, acetylene welds, bell and spigots, puddle welds, etc.
Maximum Operating Pressure (MOP) as defined in 195.2 and 195.406
Modern Pipe means pipe other than Legacy Pipe.
"Spike" Pressure Test will be defined to specify minimum test duration and minimum test pressure.
Note 1: "Applicable Roadway" means the right-of-way for a designated interstate, freeway, expressway, and other principal 4-lane arterial roadways that is not otherwise included in an HCA.
Note 2: Validated material properties required for line pipe of X42 grade and greater, and pipe ≥ 2"OD F on the mainline, and fittings, valves, flanges & components.
Note 3: If operator does not have design & material documentation that supports the internal design pressure established in accordance with 195.106 or the MOP established in accordance with 195.406 per ADB 11-01 & 12-06, segment is deemed to not have adequate documentation for purposes of this determination. Required records include, but are not limited to, mill test reports (or equivalent) showing test results for chemical & mechanical properties.
Note 4: Sampling to cover each unique combination of pipe and seam type and vintage.
Note 5: If operator does not have pressure test records in accordance with Subpart E per ADB11-01 & 12-06, segment is deemed to not have a valid pressure test.
Note 6: If operator chooses ECA option, material documentation process must be conducted as part of the ECA process step 8.
Note 7: ECA consists of material documentation, assessment, and analysis to establish material condition of pipeline and MOP. Assessments to be appropriate for threats, including Remaining Life Fatigue Analysis and reassessment interval.
Note 8: IVP is not a one-time process, but will be exercised on a recurring basis based on assessment results.
*Some state requirements may exceed Part 195. **Material and Construction

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Thank you

US DOT / PHMSA

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