



TDW Positive Material Identification
New England Pipeline Safety Regulators Conference



Kenny Greene
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Positive Material Identification

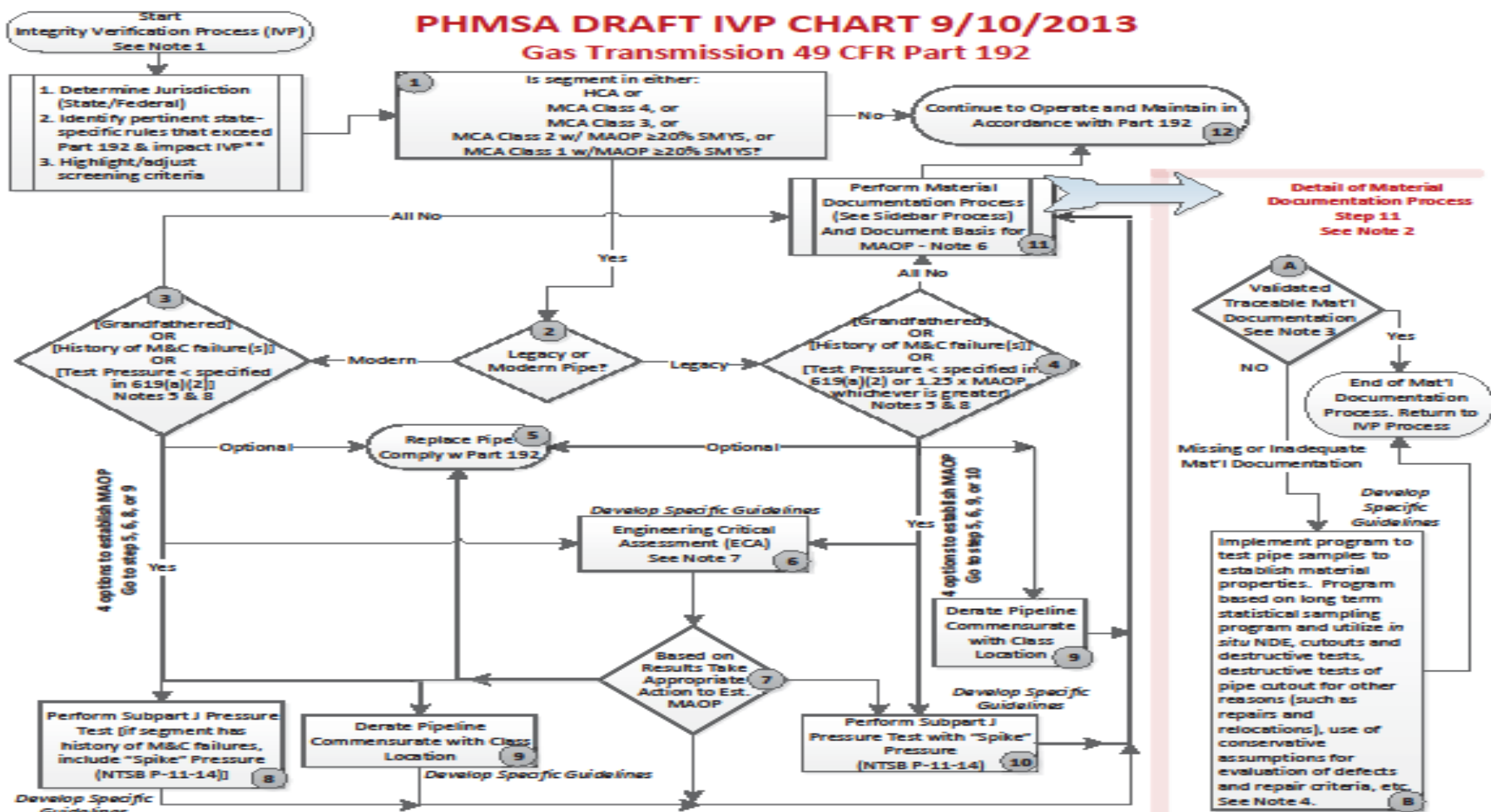
A non-destructive solution to regulatory requirements

PHMSA Advisory Bulletin ADB-2012-06 (May 2012) - *Verification of Records Establishing MAOP and MOP*

- The ADB states that:
 - ...Operators must assure that the records are reliable when calculating MAOP / MOP
 - ...these records shall be traceable, verifiable, and complete
 - ...verifiable records are those in which information is confirmed by complimentary, but separate, documentation
 - ...the Operator may need to conduct other activities such as **in-situ NDE examination**, measuring yield & tensile strength, long-seam & coating type, as well as Grade determination to justify MAOP establishment

PHMSA DRAFT IVP CHART 9/10/2013

Gas Transmission 49 CFR Part 192



Notes:

Grandfathered means pipe segments installed before July 1, 1970 with MAOP established in accordance with 192.619(c).

High Consequence Area (HCA) as defined in 192.903.

Legacy Pipe means pipe manufactured using LFERW, SSAW, Flash Weld (AO Smith), 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 fittings, arc welds, oxyacetylene welds, bell spigots, puddle weld repairs, etc.

Modern Pipe means pipe other than Legacy Pipe.

Moderate Consequence Area (MCA) means non-HCA pipe in Class 4, 3, or 2 locations, & Class 1 locations with 1 house/occupied site in PIR.

Note 1: Validation of MAOP per 192.619(d). All MAOP, while applicable, is not anticipated to be a problem and not addressed in IVP flow chart.

Note 2: Validated mat'l properties req'd for line pipe of X42 grade and greater, and pipe ≥ 2"OD if on the mainline, and fittings, valves, flanges & components.

Note 3: If operator does not have design & material documentation in accordance with 192.619(a)(1) per ADB 11-01 & 12-06, segment is deemed to not have adequate documentation for purposes of this determination. Required records include mill test reports (or equivalent) showing test results for chemical & mechanical properties.

Note 4: Sampling to cover each unique combination of pipe type and vintage.

Note 5: If operator does not have pressure test records in accordance with 192.619(a)(2) per ADB 11-01 & 12-06, segment 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 7.

Note 7: ECA consists of material documentation, assessment, and analysis to establish material condition of pipeline and MAOP, commensurate with segment-specific issues and documentation shortcomings. Assessment could include, as appropriate: ILI Program, CIS, Coating Survey, Interference Survey Remaining Life Fatigue Analysis, etc.

Note 8: Revise 192.619(a) to require min. 1.25 MAOP pressure test for new pipe.

*Some state requirements exceed Part 192. For example: (i) pressure test at 150% MAOP to establish MAOP, or (ii) all gas transmission (GT) to be classified and constructed to Class 4 requirements, or (iii) define as GT if MAOP > 125 psig, etc.



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.

B



Positive Material Identification Process

This is a Non-Destructive Evaluation (NDE) PMI process.

TDW's **PMI** process is performed on-site, in-service & non-destructively in approximately 4 hours



in lieu of line shut-down, destructive removal of coupon for Laboratory testing



Mechanical Properties Assessment (MPA) for material YS/TS

Pipeline Performance™





Mechanical Properties Assessment Indentations

- An Indenter sequentially applies a load fifteen times at a single location.





Mechanical Properties Assessment (MPA)

- The MPA indenter automatically adjusts and measures the load necessary to achieve a predetermined depth throughout the load/depth measurement processes.
- The final maximum indentation depth is 0.0059".
- The stress/strain data is analyzed to determine the EYS of that data point.



Optical Emissions Spectrometry

Pipeline Performance™





Optical Emissions Spectrometry Burn

Pipeline Performance™





Optical Emission Spectrometry

- OES determines elements present and their concentrations as well as the Carbon Equivalency value for welding purposes.
- OES uses an Argon flush and then creates a spark.
- The photons that are given off by each of the elements in the burn chamber have unique wavelengths and these wavelengths are then measured.
- From this, the concentration of each element present is calculated.
- Final maximum burn depth is < 0.002"

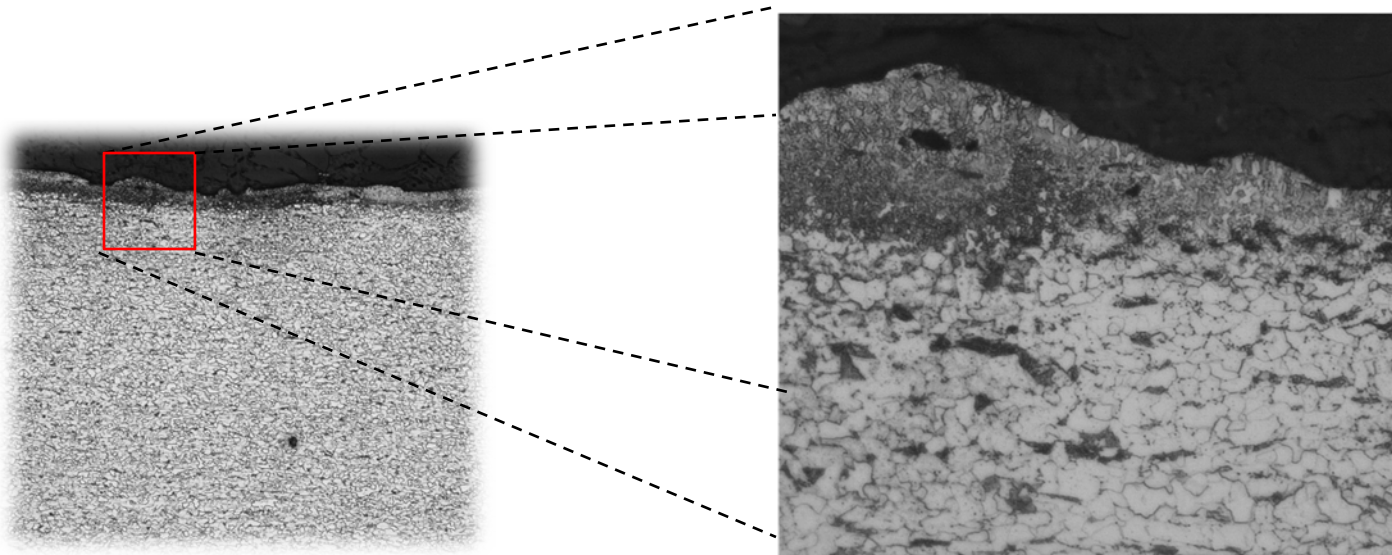


Validating Maximum OES Burn Depth

Metallographic Examination - ASTM E3-11 As Received

Specimen ID: Burn Location A

“Examination of the polished and etched cross section under the optical microscope revealed an observed maximum depth of penetration at the heat affected zone of burn location "A" as 0.0013". Away from the burn area, the microstructure appears normal for a carbon or alloy steel material.”



100X Magnification

500X Magnification

PMI — Roadmap to Validation

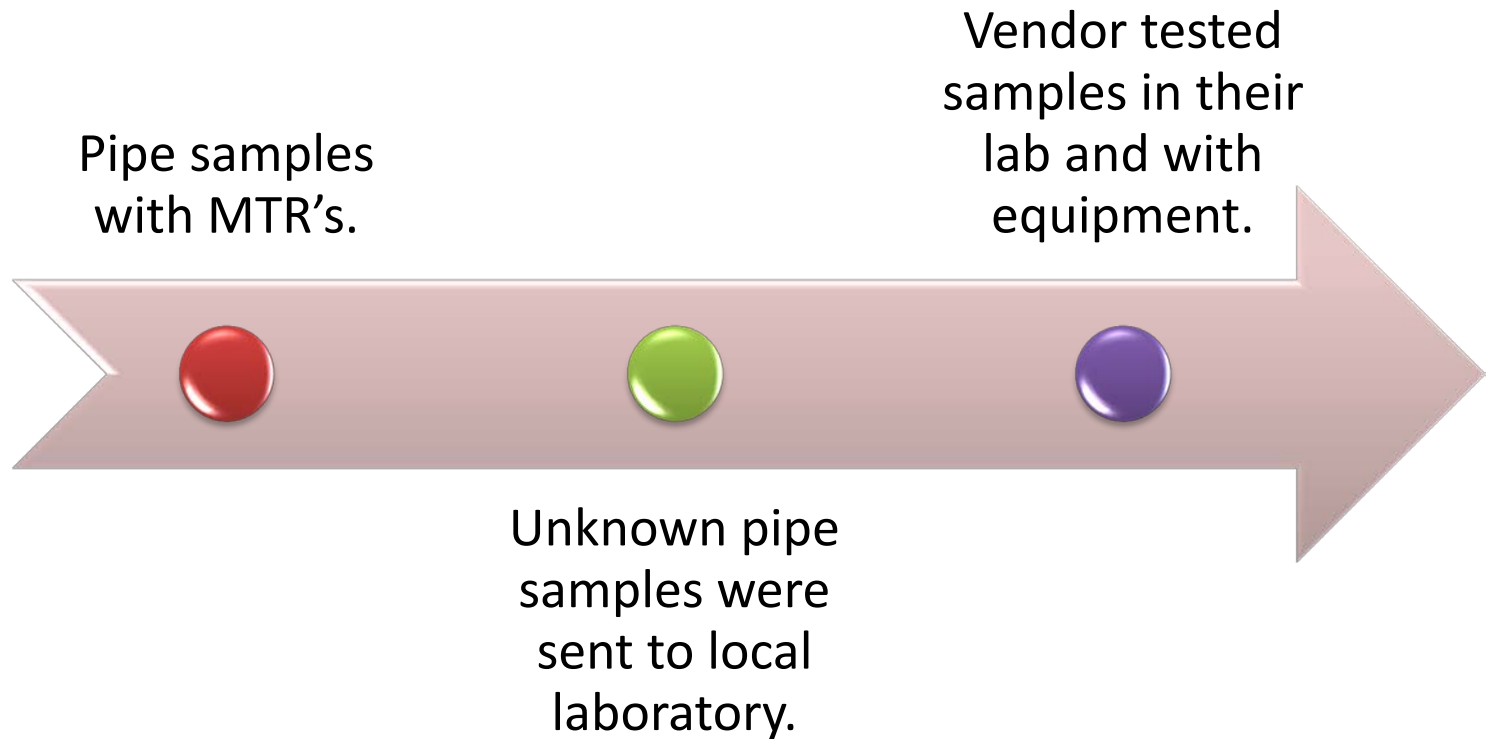


IVP Principle #3:

In Situ NDE may be used “if validated” and “if Code Approved”

PMI Roadmap – Internal Validation

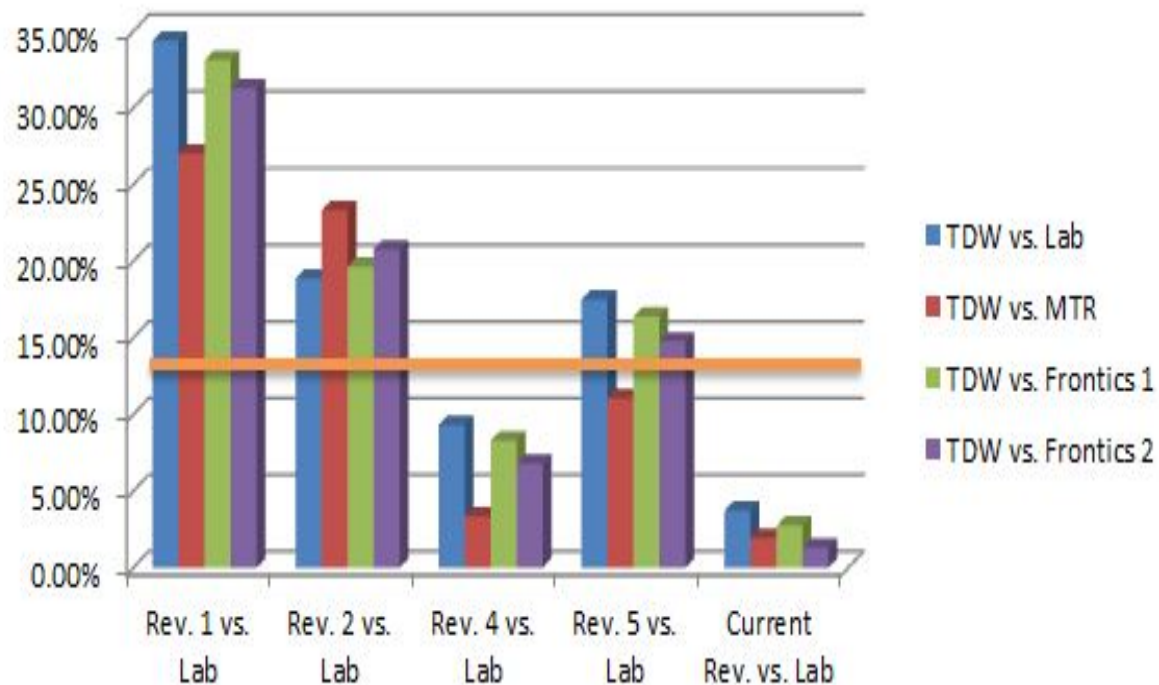
Up to 70 Ksi



PMI Roadmap – Internal Validation

Up to 70 Ksi

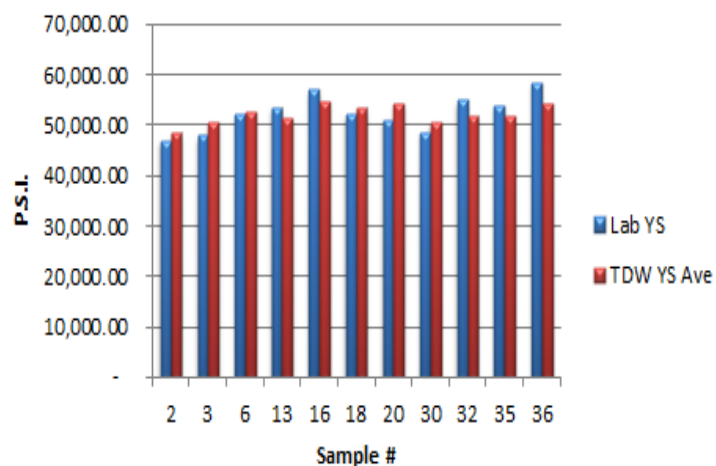
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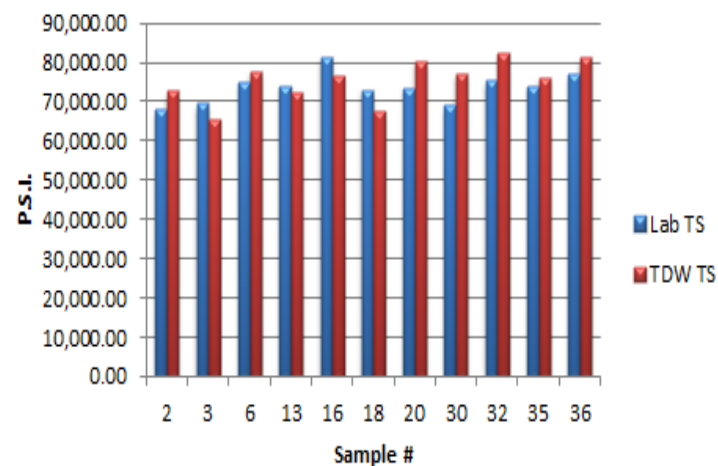


PMI Tolerance Tracking

TDW vs Lab Yield Strength



TDW vs Lab Tensile Strength

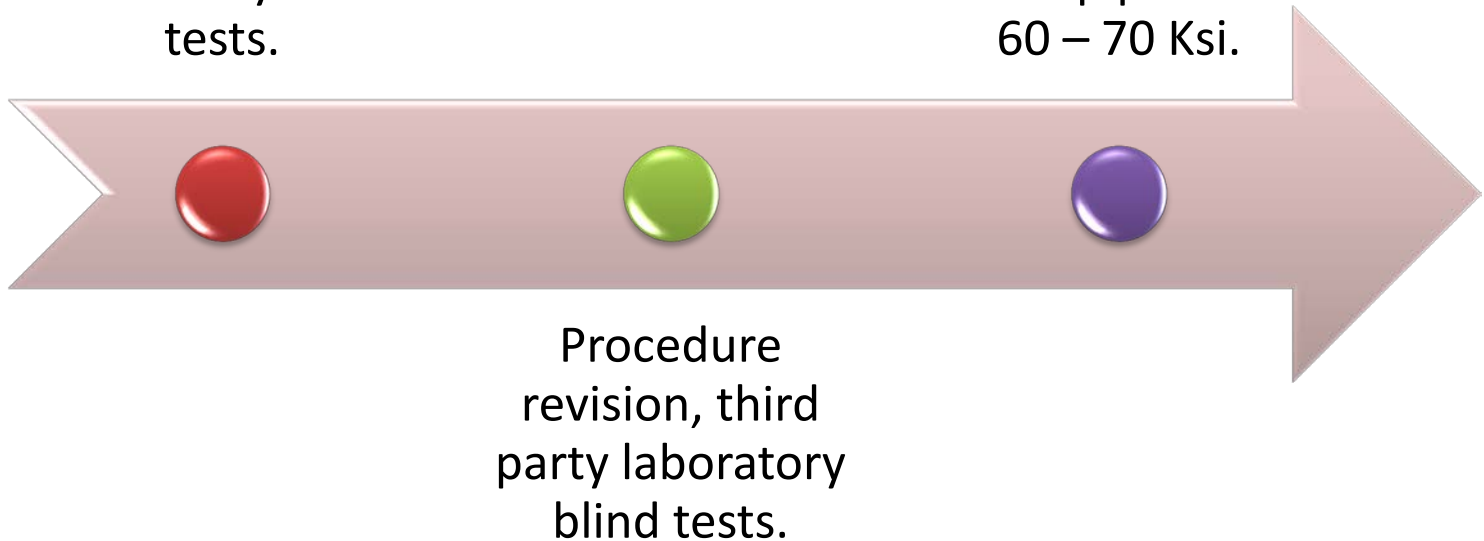


PMI Roadmap – External Validation

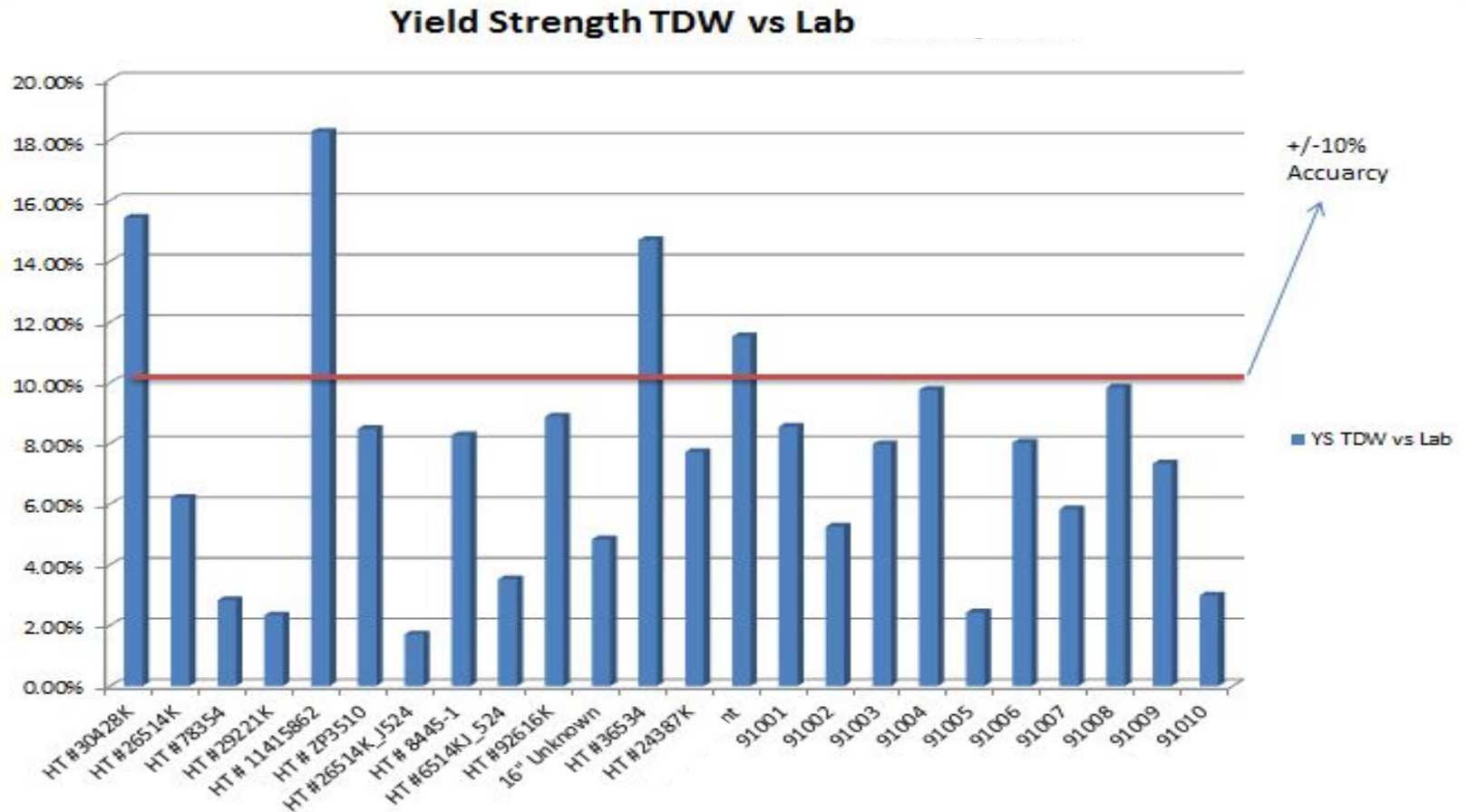
Up to 60 Ksi

Third party
laboratory blind
tests.

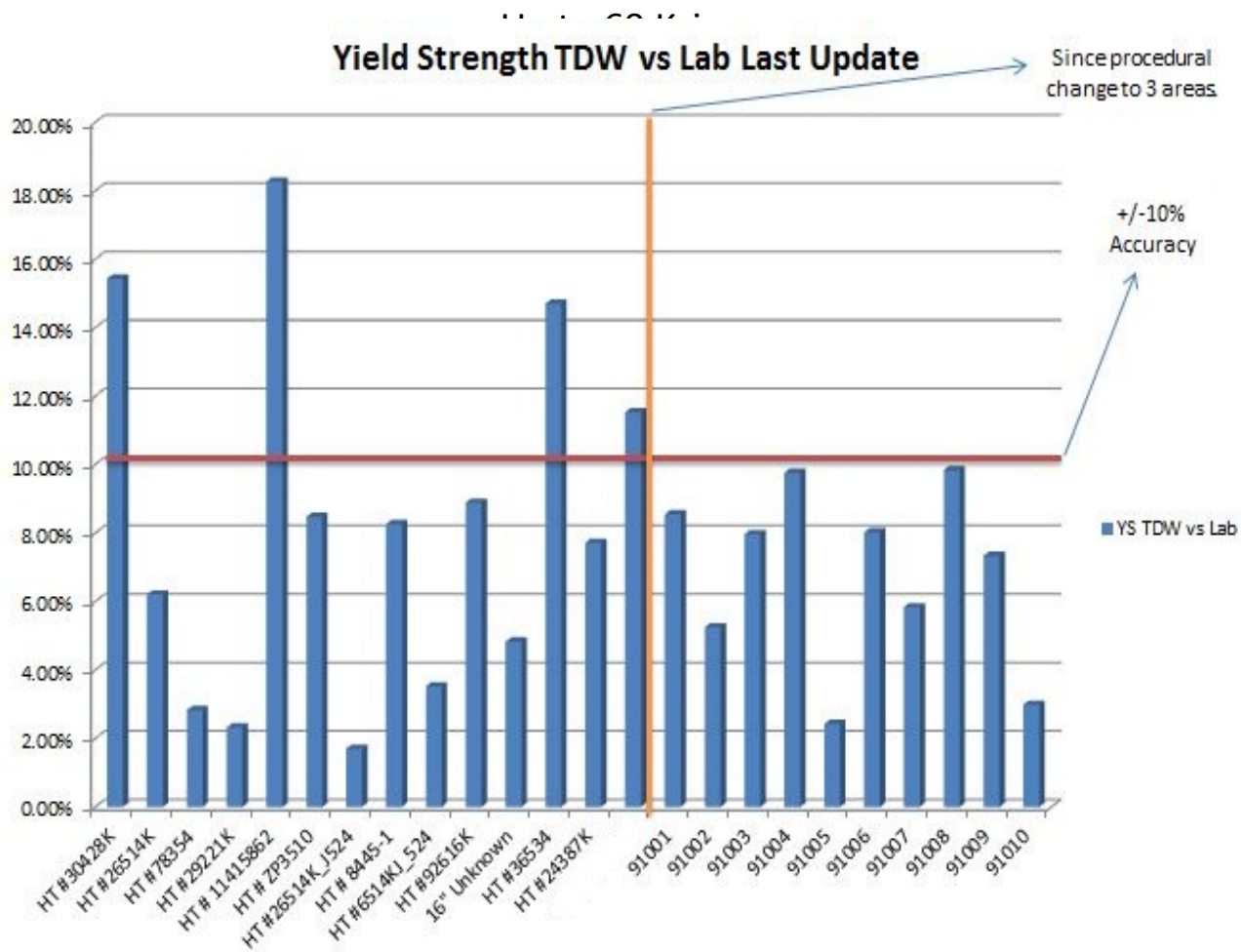
Pursuing third
party laboratory
blind tests for
PSL 1 pipe from
60 – 70 Ksi.



Positive Material Identification



PMI Roadmap – External Validation





Certified Positive Material Identification Report



PMI Test Results: XYZ Pipeline Company

T.D. Williamson, Inc.

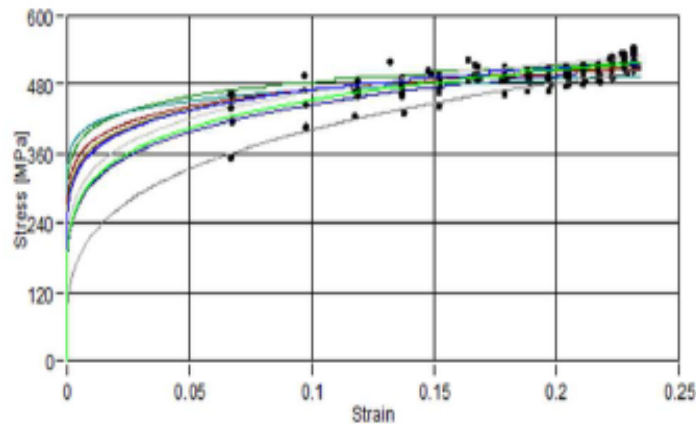
Line Name: Line ABC

Dig Number: 123

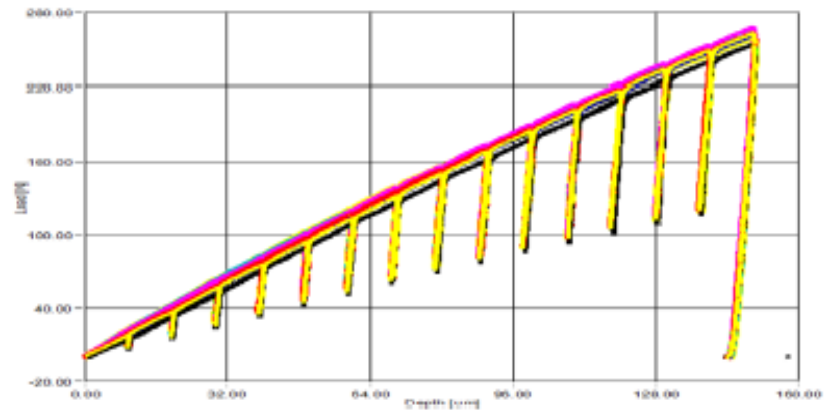
Odometer: Unknown

Nominal WT: 0.219"

OES Results									OES Results									MPA Results									
Run 1									Run 2									Yield Strength					Tensile Strength				
	C	Mn	V	Ti	Nb	S	P	CE		C	Mn	V	Ti	Nb	S	P	CE	Run 2	Run 3	Run 2	Run 3						
PMI 2013-17-1	0.206	0.359	0.000	0.022	0.005	0.000	0.000	0.283	PMI 2013-17-1	0.189	0.391	0.000	0.018	0.003	0.000	0.000	0.288	1	52.8295	52.9511	102.2610	97.5805					
PMI 2013-17-2	0.207	0.377	0.000	0.023	0.000	0.000	0.000	0.285	PMI 2013-17-2	0.206	0.355	0.004	0.017	0.003	0.000	0.000	0.280	2	52.7979	53.5857	102.3925	102.6685					
PMI 2013-17-3	0.213	0.344	0.000	0.021	0.000	0.000	0.000	0.285	PMI 2013-17-3	0.218	0.382	0.000	0.026	0.000	0.000	0.000	0.296	3	52.8644	54.7824	91.1084	90.9433					
PMI 2013-17-4	0.215	0.359	0.000	0.021	0.007	0.000	0.000	0.290	PMI 2013-17-4	0.201	0.360	0.001	0.017	0.003	0.000	0.000	0.276	4	53.3613	52.6770	98.0734	97.7066					
PMI 2013-17-5	0.195	0.364	0.000	0.019	0.004	0.000	0.013	0.271	PMI 2013-17-5	0.208	0.358	0.000	0.017	0.002	0.000	0.000	0.287	5	53.5339	52.8080	89.6639	91.8936					
AVG	0.206	0.361	0.000	0.021	0.003	0.000	0.004	0.283	AVG	0.204	0.375	0.001	0.019	0.002	0.000	0.000	0.281	Avg	53.08	53.36	96.70	96.16					
ST DEV	0.007	0.011	0.000	0.001	0.003	0.000	0.005	0.006	ST DEV	0.009	0.015	0.002	0.004	0.001	0.000	0.000	0.009	Overall AVG	53.22		96.43						
	C	Mn	V	Ti	Nb	S	P	CE																			
OES Overall AVG	0.206	0.360	0.001	0.020	0.003	0.000	0.002	0.282																			
OES Overall STDEV	0.006	0.015	0.001	0.003	0.002	0.000	0.004	0.008																			



Stress vs Strain



Load vs Depth

Date of Inspection	NDE Technician	NDE Technician Signature	Client Review	Date of Review
11/7/2013	Kenny Greene	<i>Kenny Greene</i>		



Specifications for TDW PMI NDE Services

- The **PMI** process is performed on-site, in-service & non-destructively
- Approximate In-ditch time = 4 hours
- No Pressure reduction requirements
- Minimum exposed pipe = 3 ft.
- Target excavation size = 8ft.
- MPA temperature operating range 14°F to 115°F (-10°C to -46.1°C)
- OES temperature operating range 32°F to 122°F (0°C to 50°C)*
- MPA maximum indentation depth 0.006" (0.152mm)
- OES maximum burn depth 0.002" (0.033mm)
- PLS1 pipe \leq 60Ksi - all vintages. Grading per API5L-Tbl 4&6
- PLS2 pipe \leq 60Ksi - YS, TS, CA, & CE Properties (excludes CVN)
- Higher grade pipe materials currently in development and near completion for material \leq 70 Ksi

TDW PMI accuracy tolerances

- Ultimate Yield Strength (UYS) \pm 10% with a 95% Confidence Level
- Ultimate Tensile Strength (UTS) \pm 10% with a 95% Confidence Level
- Carbon percentage (C) \pm 25% with a 85% Confidence Level*
- Manganese percentage (Mn) \pm 20% with a 90% Confidence Level*

*The C & Mn results are % of a Laboratory % values.



Applications for TDW PMI NDE Services

- TDW's In-service Non-destructive PMI in lieu of destructive Lab testing
- All pipe vintages $\leq 60\text{Ksi}$
- Higher grade pipe materials currently in development
- 60Ksi to $\leq 70\text{Ksi}$ in-house validation complete
- Round #1 *Referee Analysis* by Kiefner & Assoc. complete
- Revisions completed for High Strength material analysis
- Round #2 *Referee Analysis* by Kiefner & Assoc. scheduled



TDW NDE PMI Approval STATUS

IVP Principle #3:

- *In Situ* NDE may be used “if validated” and “if Code Approved”

Status:

- PHMSA review is complete and they have sent to the D.O.T. – Office of Management & Budgeting (OMB) with recommended approval
- Special Permit
- “Other Technologies” may be used per **49 CFR 192.937(C)(4)** and receive a “No Objection” review when in an HCA



Thank you!

**For further info or on-site demo please
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