TDW Positive Material Identification
New England Pipeline Safety Regulators Conference

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www.tdwilliamson.com
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

Start Integrity Verification Process (IVP)
See Note 1

1. Determine Jurisdiction
   [State/Federal]
2. Identify pertinent state-specific rules that exceed
   Part 192 & impact IVP
3. Highlight/adjust screening criteria

Continue to Operate and Maintain in
Accordance with Part 192 12

Perform Material Documentation Process
(See Sidebar Process) and Document basis for
MAOP - Note 6

Optional

Replace Pipe
Comply w Part 192

Option

Develop Specific Guidelines

Develop Specific Guidelines

Derate Pipeline
Commensurate with Class Location 7

Derate Subpart J Pressure Test with "Spike" Pressure
(NTSB P-11-14)

Based on Results Take
Appropriate Action to Est. MAOP

Applicable MAOP
(See Note 5, 6, or 7)

Develop Specific Guidelines

Engineering Critical Assessment (ECA)
See Note 7

Perform Subpart J Pressure Test (if segment has
history of M&C failures, includes "Spike" Pressure
[NTSB P-11-14])

Develop Specific Guidelines

Legacy or Modern Pipe?

Modern

Legacy

[Grandfathered]

Modern Pipelines include use of HCA or MCA Class 3,
or MCA Class 2 w/ MAOP 220% SMYS, or
MCA Class 1 w/ MAOP 220% SMYS.

History of M&C Failure

History of M&C Failure

Test Pressure < specified in 619(a)(2) or 1.25 x MAOP,
whichever is greater, Notes 3 & 5.8

Replace Pipe
Comply w Part 192

Validate Traceable Mat'l Documentation
See Note 2

End of Mat'l Documentation Process. Return to IVP Process

Missing or Inadequate Mat'l Documentation

Develop Specific Guidelines

Implement program to test pipe sample to establish material
properties. Program based on long-term statistical
sampling program in situ NDE, cutouts, and destructive
tests. Develop appropriate tests for pipe cutout for other
reasons such as repairs and relocations, use of
conservative assumptions for evaluation of defects and
repair criteria, etc. See Note 8.

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 LEBW, SAW, 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 whimble bends, miter > 3 degrees, Dresser Couplings, non-standard fittings, arc welds, any acetylene welds, bell spigots, puddle weld repairs, etc.

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

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

Note 2: Validation methodology for pipe of X42 grade and greater, and pipe > 7" OD. In 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 ADR 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 long-term 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 ADR 11-01 & 12-06, segment deemed not to have a valid pressure test.

Note 6: ECA consists of material documentation, assessment, and analysis to establish material condition of pipeline and MAOP, commensurate with segment-specific issues and documentation shortfalls. Assessment could include, as appropriate: LI Program, CIS, Coating Survey, Interference Survey Remaining Life Fatigue Analysis, etc.

Note 8: Revise 12/6/13(a) to require min. 1.23 MAOP pressure test for new pipe.

**Some state requirements exceed Part 192. For example: [i] pressure test at 130% 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 and utilize in situ NDE cutouts and destructive tests, 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.
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
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
Optical Emissions Spectrometry
Burn
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
IVP Principle #3:
In Situ NDE may be used “if validated” and “if Code Approved”
PMI Roadmap – Internal Validation

Up to 70 Ksi

Pipe samples with MTR’s.

Vendor tested samples in their lab and with equipment.

Unknown pipe samples were sent to local laboratory.
PMI Roadmap – Internal Validation

Up to 70 Ksi
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.

Procedure revision, third party laboratory blind tests.

Pursuing third party laboratory blind tests for PSL 1 pipe from 60 – 70 Kσi.
Positive Material Identification

![Graph showing Yield Strength TDW vs Lab with accuracy +/- 10% indicated.](image-url)
PMI Roadmap – External Validation

Yield Strength TDW vs Lab Last Update

Since procedural change to 3 areas.

+-10% Accuracy

YS TDW vs Lab

HT #904-28K, HT #851, HT #7854, HT #852, HT #1145962, HT #78314K, HT #65144K, HT #534, HT #8465-1, HT #518624, HT #534, HT #24367K, HT #91001, HT #91002, HT #91003, HT #91004, HT #91005, HT #91006, HT #91007, HT #91008, HT #91009, HT #91010.
### PMI Test Results: XYZ Pipeline Company

#### OES Results

<table>
<thead>
<tr>
<th>Line Name:</th>
<th>Line ABC</th>
<th>Odometer:</th>
<th>Unknown</th>
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<tbody>
<tr>
<td>Dlg Number:</td>
<td>123</td>
<td>Nominal WT:</td>
<td>0.219</td>
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</table>

#### Run 1

<table>
<thead>
<tr>
<th>C</th>
<th>Mn</th>
<th>V</th>
<th>Ti</th>
<th>Nb</th>
<th>S</th>
<th>P</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.206</td>
<td>0.395</td>
<td>0.000</td>
<td>0.022</td>
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#### Run 2

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<th>Mn</th>
<th>V</th>
<th>Ti</th>
<th>Nb</th>
<th>S</th>
<th>P</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.189</td>
<td>0.391</td>
<td>0.000</td>
<td>0.018</td>
<td>0.003</td>
<td>0.000</td>
<td>0.283</td>
<td></td>
</tr>
</tbody>
</table>

#### MPA Results

<table>
<thead>
<tr>
<th>Yield Strength</th>
<th>Tensile Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>Run 2</td>
</tr>
<tr>
<td>Run 1</td>
<td>Run 2</td>
</tr>
<tr>
<td>52.8295</td>
<td>52.3511</td>
</tr>
</tbody>
</table>

#### Stress vs Strain

- Date of Inspection: 11/7/2013
- NDE Technician: Kenny Greene
- NDE Technician Signature: [Signature]
- Client Review:
- Date of Review:
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 <= 60Ksi - all vintages. Grading per API5L-Tbl 4&6
- PLS2 pipe <=60Ksi - YS, TS, CA, & CE Properties (excludes CVN)
- Higher grade pipe materials currently in development and near completion for material <= 70 Ksi

**TDW PMI accuracy tolerances**

- Ultimate Yield Strength (UYS) +/-10% with a 95% Confidence Level
- Ultimate Tensile Strength (UTS) +/-10% with a 95% Confidence Level
- Carbon percentage (C) +/-25% with a 85% Confidence Level*
- Manganese percentage (Mn) +/-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 $\leq$ 60Ksi
- Higher grade pipe materials currently in development
- 60Ksi to $\leq$ 70Ksi 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
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 contact:

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