Practical Risk Modeling Challenges

PHMSA Pipeline Risk Modeling Methodologies Public Workshop

PHMSA - Office of Pipeline Safety

Steve Nanney and Ken Lee

September 10, 2015

Risk Modeling Challenges

- **Data needs**
- **Meaningful models**
- **Performance must achieve functional goals**
  - **Identifying risks/threats**
  - **Tool for managing/reducing risk**

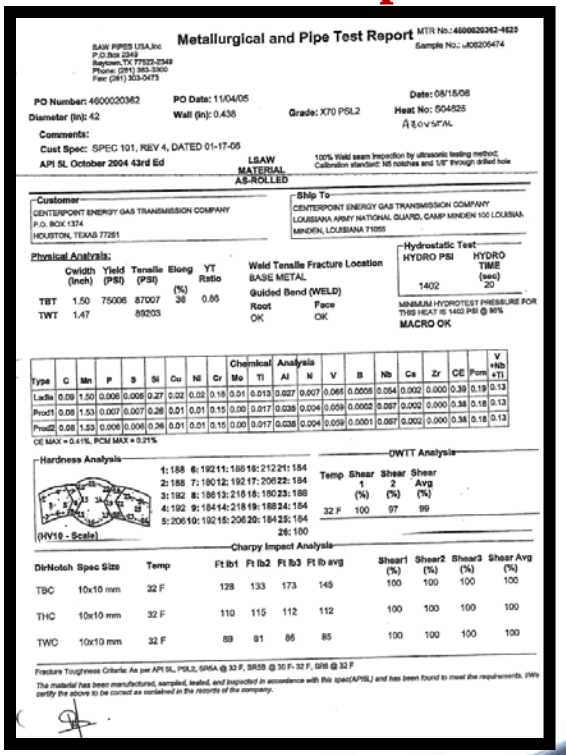
Data Needs

- **Every modeling approach depends on data**
  - **Best model is, in fact, effectively a poor model if the underlying data are suspect**
  - **Effective risk models require a strong industry effort to:**
    - **Obtain and validate all data that is used in industry risk models**

Data Needs

- **Modeling approach depends on data:**
  - **Basic understanding of as-built pipeline material configuration and characteristics is critical**
  - **Documentation efforts such as Integrity Verification Process (IVP) are important for success**
  - **Model results/associated risk drivers can be used to identify most important areas to verify data quality**

Mill Test Report



Metallurgical and Pipe Test Report

SAW PIPES USA,Inc
P.O.Box 2349
Baytown, TX 77522-2349
Phone: (281) 383-3300
Fax: (281) 303-0473

MTR No.: 4500020362-4623
Sample No.: IJ06205474

PO Number: 4500020362 | PO Date: 11/04/05 | Date: 08/15/06
Diameter (in): 42 | Wall (in): 0.438 | Grade: X70 PSL2 | Heat No: 504525

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	1.50	75006	87007	38	0.86
TWT	1.47		88203		

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 @ 96%
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	0.008	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	0.038	0.004	0.059	0.0002	0.057	0.002	0.000	0.38	0.18	0.13
Prod2	0.08	1.53	0.006	0.006	0.26	0.01	0.01	0.15	0.00	0.017	0.038	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: 215	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: 100

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	91	86	85	100	100	100	100

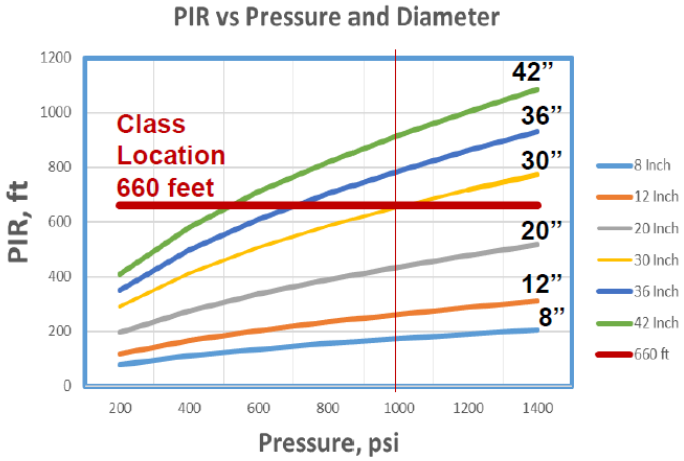
Fracture Toughness Criteria: As per API 5L, PSL2, SR6A @ 32 F, SR5B @ 30 F- 32 F, SR8 @ 32 F

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

Meaningful Models

- **All approaches apply the same basic definition of risk**

Risk = Likelihood * Consequence



Meaningful Models

- Likelihood (threats)
  - Time-Dependent
  - Stable
  - Time-Independent
  - Interactive threats

- Consequence (receptors)
  - Population (HL, GT)
  - Unusually Sensitive Areas (HL)

Risk Model Performance

- **Regardless of approach, risk results/risk profile must reasonably match operational history**

NOTICE: This report is required by 49 CFR Part 195. Failure to report can result in a civil penalty not to exceed $100,000 for each violation for each day that such violation persists except that the maximum civil penalty shall not exceed $1,000,000 as provided in 49 USC 60122.

OMB NO: 2137-0047

EXPIRATION DATE: 7/31/2015

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

ACCIDENT REPORT – HAZARDOUS LIQUID PIPELINE SYSTEMS

Report Date _____

No. _____
(DOT Use Only)

A federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act unless that collection of information displays a current valid OMB Control Number. The OMB Control Number for this information collection is 2137-0047. Public reporting for this collection of information is estimated to be approximately 10 hours per response, including the time for reviewing instructions, gathering the data needed, and completing and reviewing the collection of information. All responses to this collection of information are mandatory. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to: Information Collection Clearance Officer, PHMSA, Office of Pipeline Safety (PHP-30) 1200 New Jersey Avenue, SE, Washington, D.C. 20590.

INSTRUCTIONS

Important: *Please read the separate instructions for completing this form before you begin. They clarify the information requested and provide specific examples. If you do not have a copy of the instructions, you can obtain one from the PHMSA Pipeline Safety Community Web Page at http://www.phmsa.dot.gov/pipeline/library/forms.*

PART A – KEY REPORT INFORMATION Report Type: *(select all that apply)* ☐ Original ☐ Supplemental ☐ Final

1. Operator's OPS-issued Operator Identification Number (OPID): / / / / / /

Meaningful Models

- National Transportation Safety Board (NTSB*) references 4 general approaches to risk models
  - Subject Matter Expert (SME)
  - Scenario-Based Models
  - Relative Assessment Models ("index" models)
  - Probabilistic Models

*NTSB/SS-15/01 Integrity Management of Gas Transmission Pipelines in High Consequence Areas

Meaningful Models

- **Subject Matter Expert (SME)**
  - **Expert group-based process based on the group's assessment of risk factors**
  - **Structured process needed to integrate and balance the panel's knowledge on risk factors**
- **Scenario-Based Models**
  - **Evaluate risks by building scenario that might occur following a postulated "initiating event" such as a pipeline leak**
  - **Likelihood and consequences evaluated by group of knowledgeable experts**

Meaningful Models

- **Relative assessment models (“Index” Models)**
  - **System-wide weighting factors can obscure uncommon, but high-risk threats**
  - **Acceptable for baseline assessment prioritization phase of IMP; most used industry approach**
  - **Not as useful for investigative application of risk evaluations**

Meaningful Models

- **Probabilistic models**
  - **Data intensive**
  - **Have quantitative advantages over relative risk models**
  - **Generally more useful for investigative application of risk evaluations**

Meaningful Models

- **Probabilistic models -where do we go?**
  - **Should Probabilistic Models be the direction Industry and PHMSA evolve to use for risk analysis approaches?**
    - **Fault tree/event tree**
    - **Bayesian**
    - **Power law**
    - **Other quantitative approaches?**

Risk Model Performance

- **Risk models must meet functional/ performance requirements**
  - **Must be able to identify risks (including emergent risks)**
  - **Must be able to be used as a tool for managing/reducing risk**

Risk Model Performance

- **Risk models must meet functional/ performance requirements**
  - **Identification of preventive & mitigative (P&M) measures:**
    - ***Can the risk assessment approach be used to identify and evaluate the impact on risk of P&M measures?***
    - **Is the model sensitive to individual parameter changes?**

Risk Model Performance

- **Risk model must meet functional/ performance requirements**
  - **Periodic evaluation process:**
    - ***Will the risk analysis process incorporate all integrity aspects necessary for an operator to determine if operational risk is going up or down over time?***
    - **Many current risk models show little difference in estimated risk over time**

Risk Model Performance

- **Risk models must meet functional/ performance requirements**
  - **Assessment interval determination process:**
    - ***Is the risk analysis integration assessment interval determination process meaningful, or just a low-impact factor for the ILI analysts to "consider" when determining intervals?***
    - **Actual practical impact of risk results on assessment interval determination is very limited in many PHMSA observed cases**

Risk Model Performance

- **Risk model must meet functional/ performance requirements**
  - **Continual assessment technique selection process:**
    - ***Can the risk analysis method for integrity threat assessment thresholds demonstrate variations over time due to the impact of actual observed field conditions?***
    - **Important to apply System-specific information for threats versus overall industry estimations of threat likelihoods**

Risk Model Performance

- **Example #1 (data)**
  - **Cracking Failure – multiple of several years**
  - **Pre-Code Pipe**
  - **No Pressure Test**
  - **Pipe and Seam Toughness**
    - **Known or Unknown**
  - **What type model should be used?**
  - **Should more than one model be applied?**

Risk Model Performance

- **Example #2 (model structure)**
  - **Index Model used**
  - **Threat weightings dominated by third party damage (TPD) (43%) and external corrosion (EC) (30%)**
  - **Reportable incident data indicate incident causes for the system: TPD 14%, EC 11%**
  - **How close should threat category modeling match the pipeline's operating history?**

Risk Model Performance

- **Example #3 (Emergent Risk)**
  - **Operator has had more than one seam failure over the past two years on a 1940-50's era line that has not been pressure tested to Part 195 Subpart E requirements.**

Should operator's risk model be expected to show an increased level of risk for these line segments?

If significant increase is calculated, how would results be applied to pipeline operations (e.g., if operations staff is not concerned)?

Risk Model Performance

- **Example #4 (Technical Evaluations)**
  - **Operator has performed a fatigue analysis to evaluate pressure cycling impact on a line that may have cracking susceptibility.**

Should operator's risk model be expected to reflect the results of this level of analysis in the line's risk profile?

How would any updated risk results be reflected in the determination of the assessment interval for this line?

Going Forward

- **Address related NTSB rec.**
- **Evaluate input from this Workshop**
- **Region - inspection enhancements and improve protocols**
- **Risk Modeling Methodology**
  - **Establish a Working Group**

Reference Risk Modeling Methodology Work Group

- PHMSA work group
- Process for industry/stakeholder input
- Process for periodic review/update
- Develop “Technical Guidance” documents

Reference Risk Modeling Methodology Work Group

- **PHMSA "Technical Guide" documents would provide the basis and details of acceptable approaches for evaluating respective threat/consequence categories**
  - **Not mandatory, but available for use/adaptation**

Reference Risk Modeling Methodology Work Group

- **Provide common reference for comparison of risk approaches by both industry and regulators**

- **Downloadable supporting technical tools (spreadsheets, etc.) as necessary**

811
Know what's below.
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DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

Thank You

Steve Nanney and Ken Lee

US DOT / PHMSA