

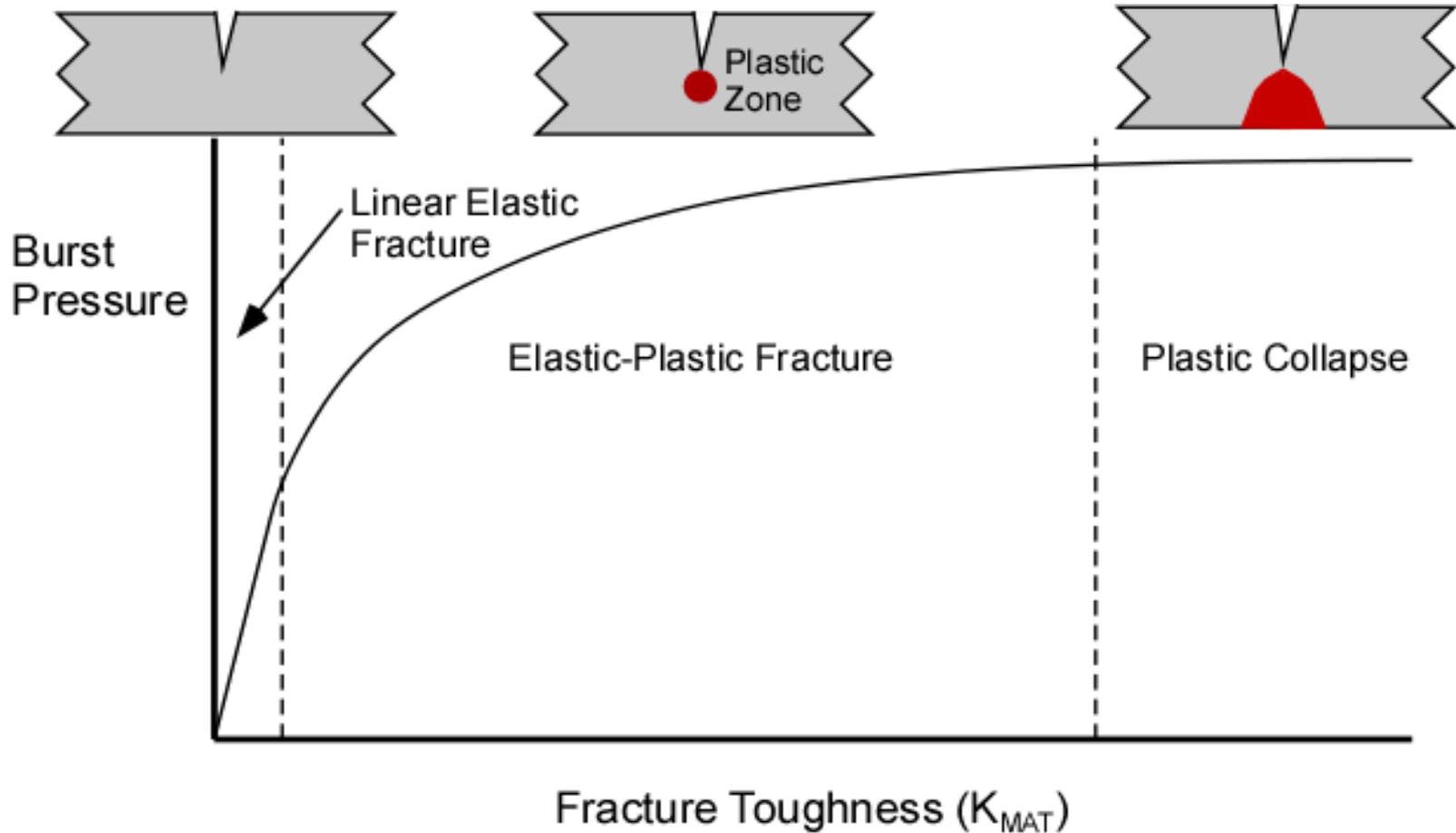
Assessment of Seam Weld Cracks: *Technology Advances and Myth Busters*

Ted L. Anderson, Ph.D., P.E.

- What every physician knew in 1990:
 - Peptic (i.e. stomach) ulcers are caused by stress.
 - Treatment options include prescription acid blockers such as Tagamet®.
- Unfortunately, what “everyone knew” turned out to be wrong.
 - Ulcers are actually caused by H. pylori bacteria.
 - Antibiotics provide the most effective treatment.
 - This finding was published in 1984 by Australian researchers, but the medical community did not accept their conclusions for nearly a decade.

Failure of Pipes with Seam Weld Cracks

Accurate Models Must Incorporate 3 Regimes



Myth #1: Log-Secant Model

- Original Log-Sec Model (circa 1970):

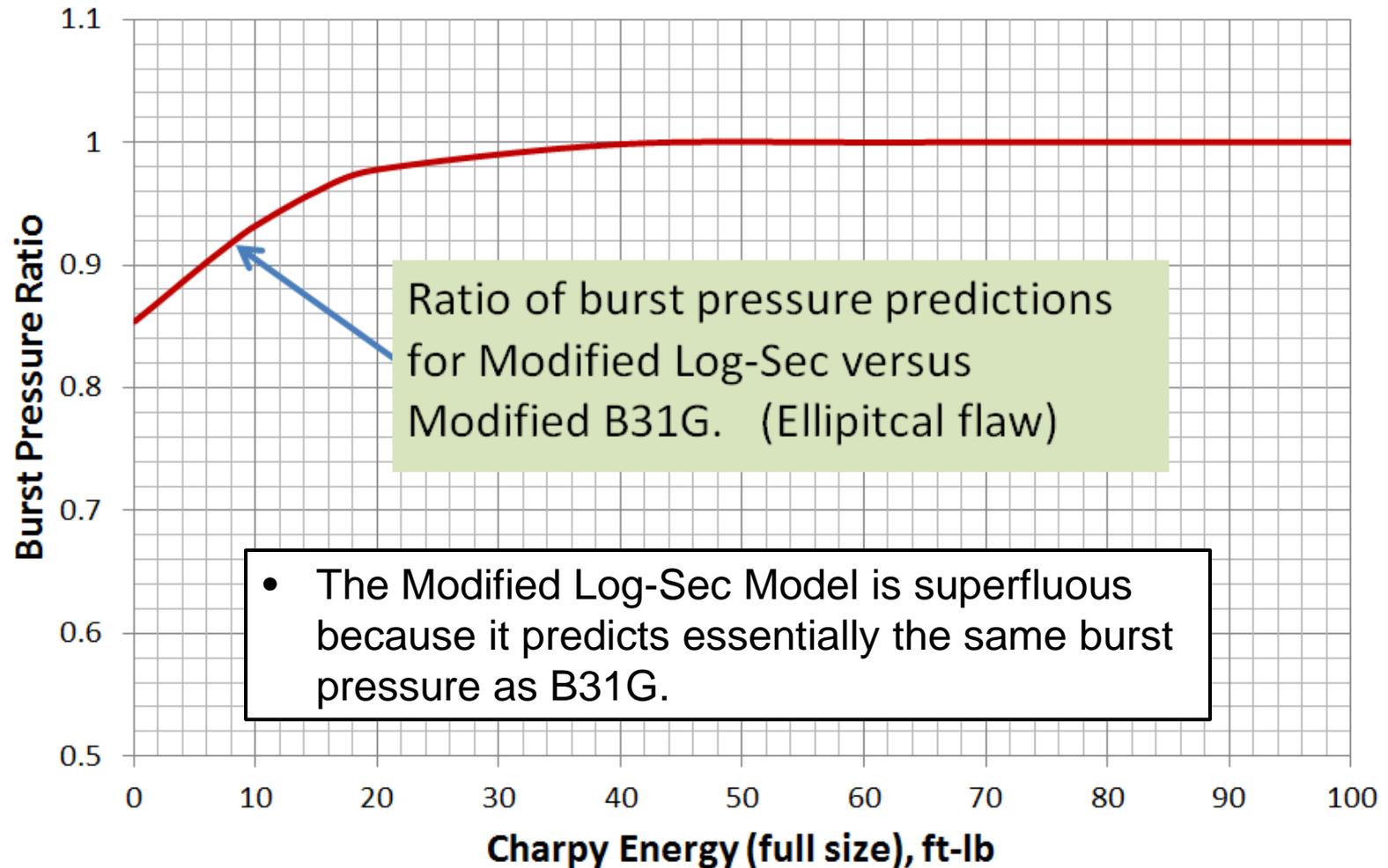
Modeling Error

- Modified Log-Sec Model (2008):

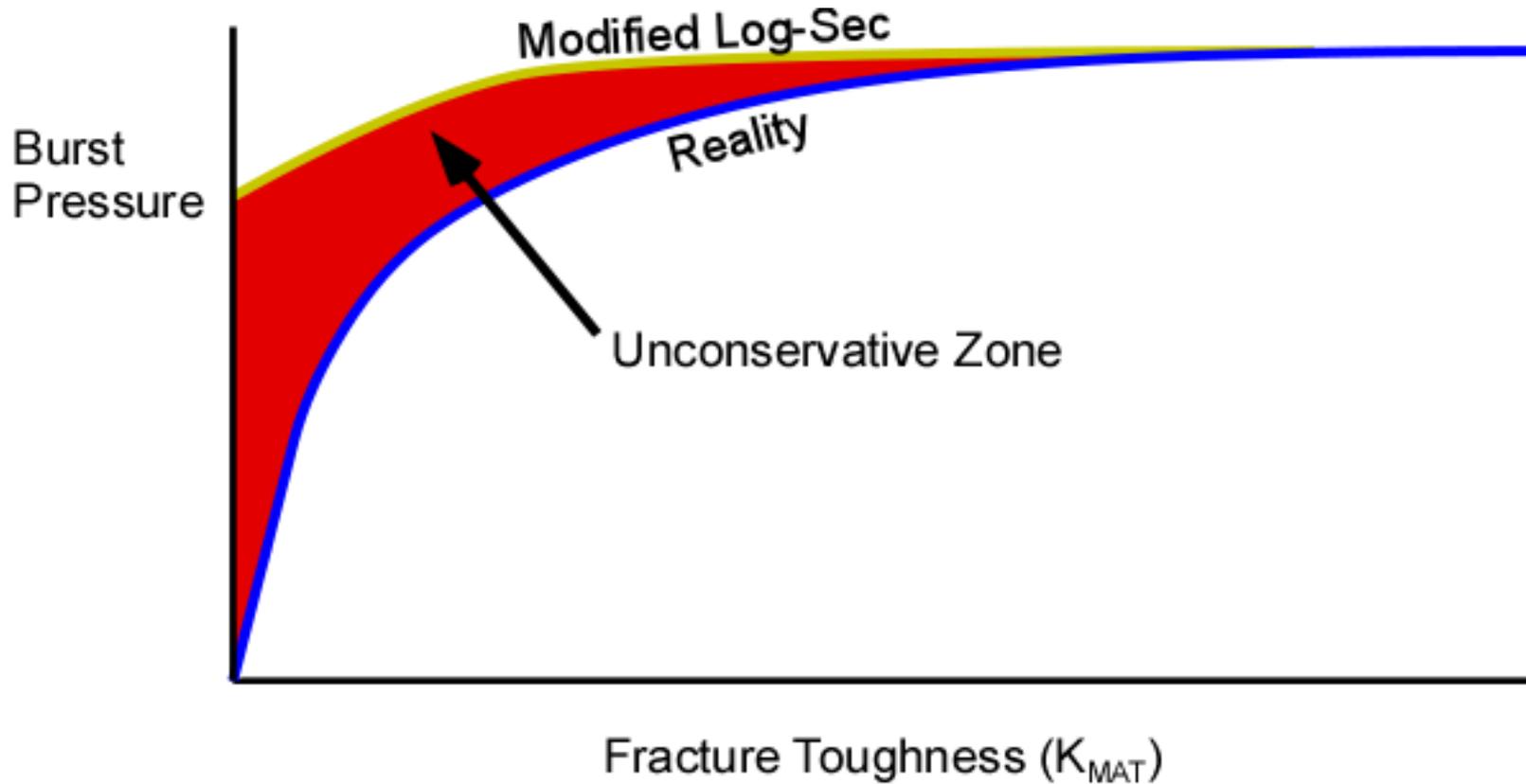
Modeling Error x Adjustment Factor

Modified Log-Sec versus Modified B31G

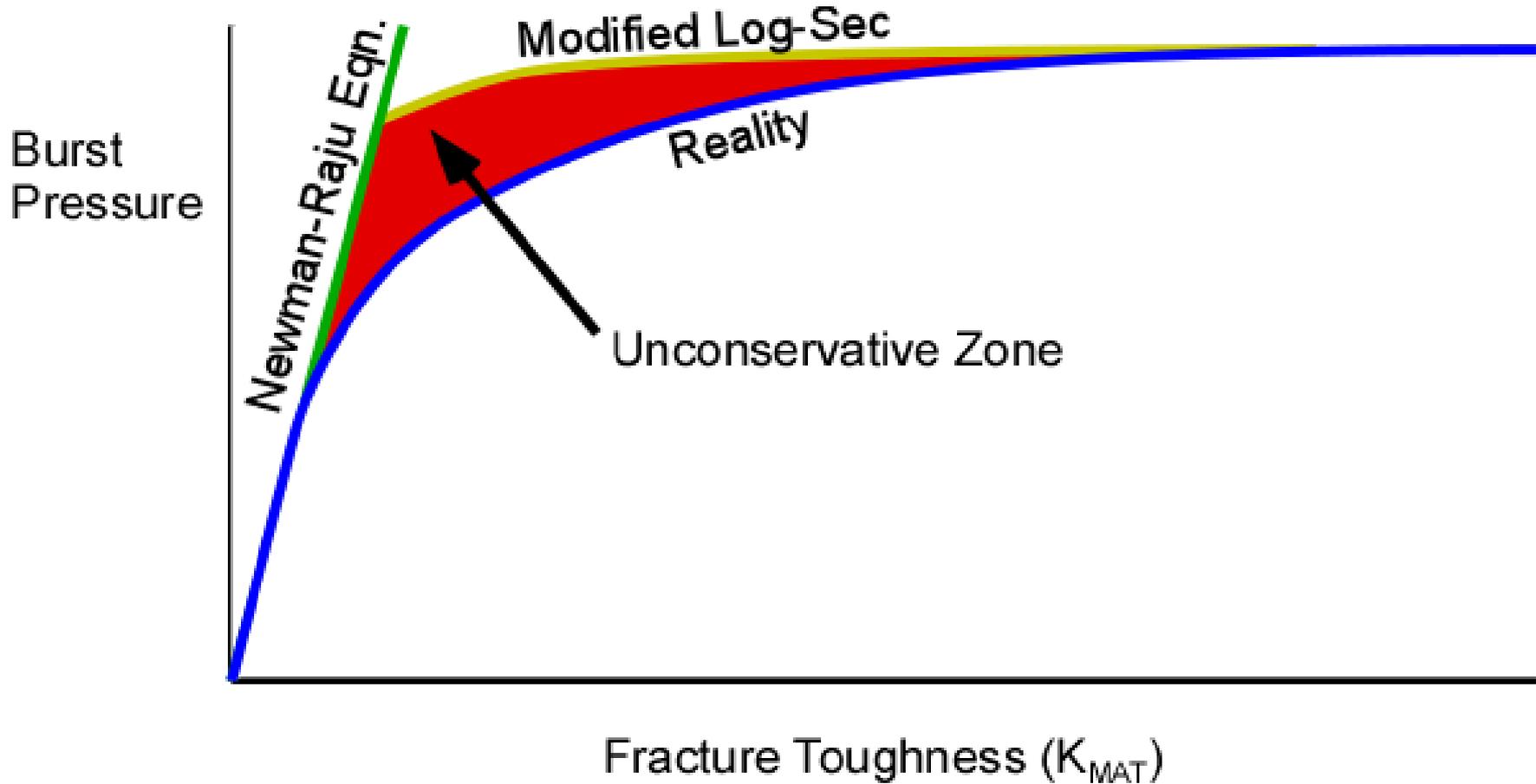
22-inch Pipe, $t = 0.312$ inch
4-inch Long x 25% t Crack



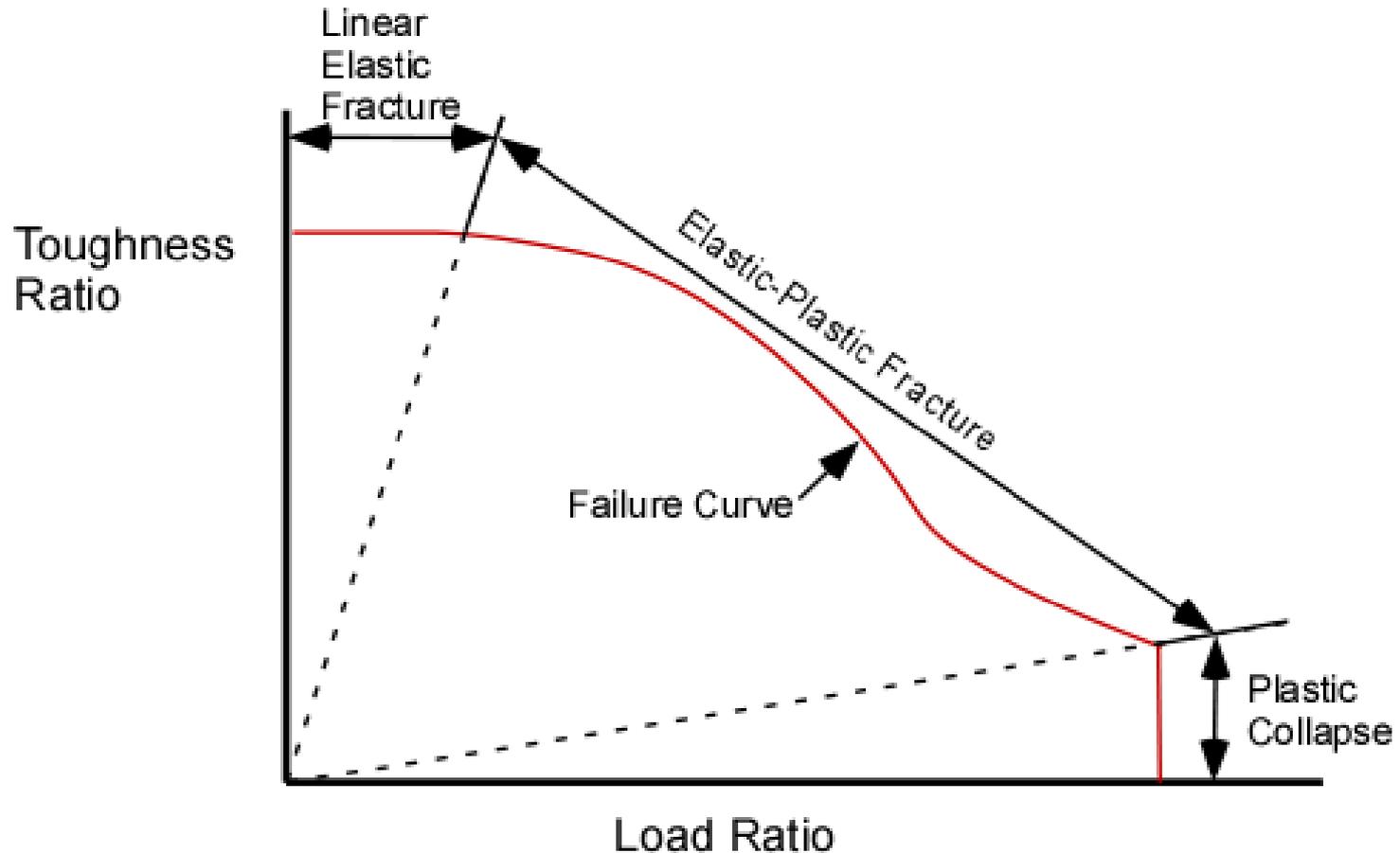
Modified Log-Sec versus Reality



Latest Proposal Two-Model Approach



Alternative Approach: Failure Assessment Diagram (FAD)



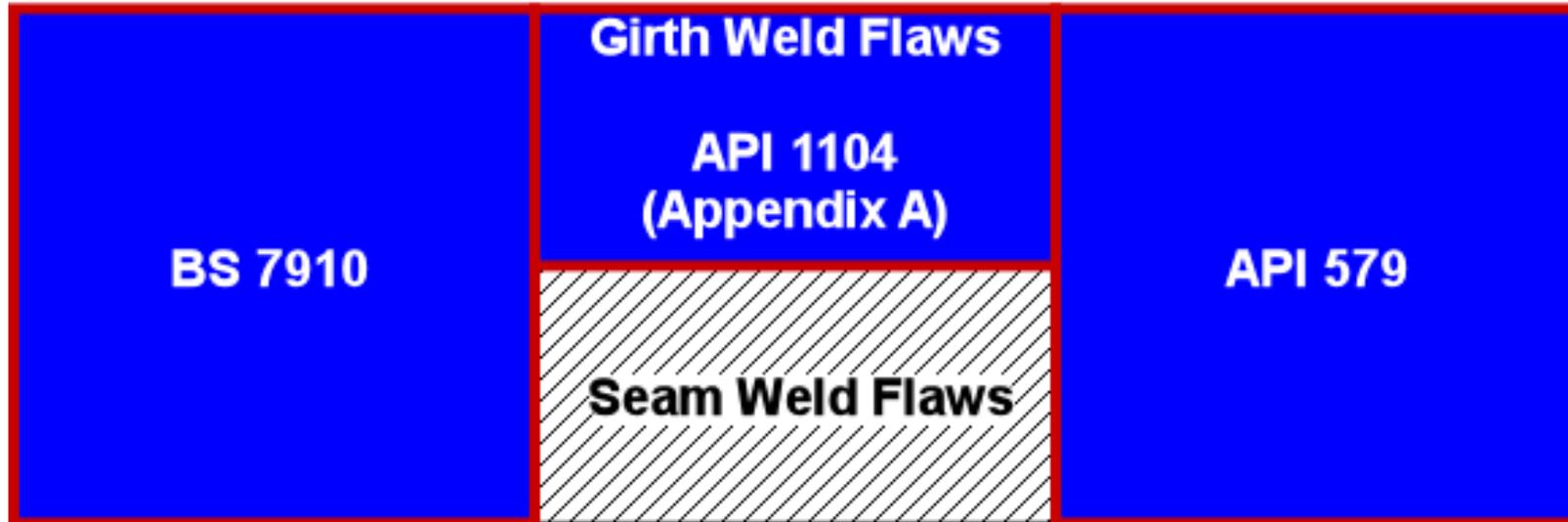
- The FAD approach spans all three failure regimes.

Industry Standards that Apply the FAD Method in the Oil and Gas Industry

Upstream

Midstream

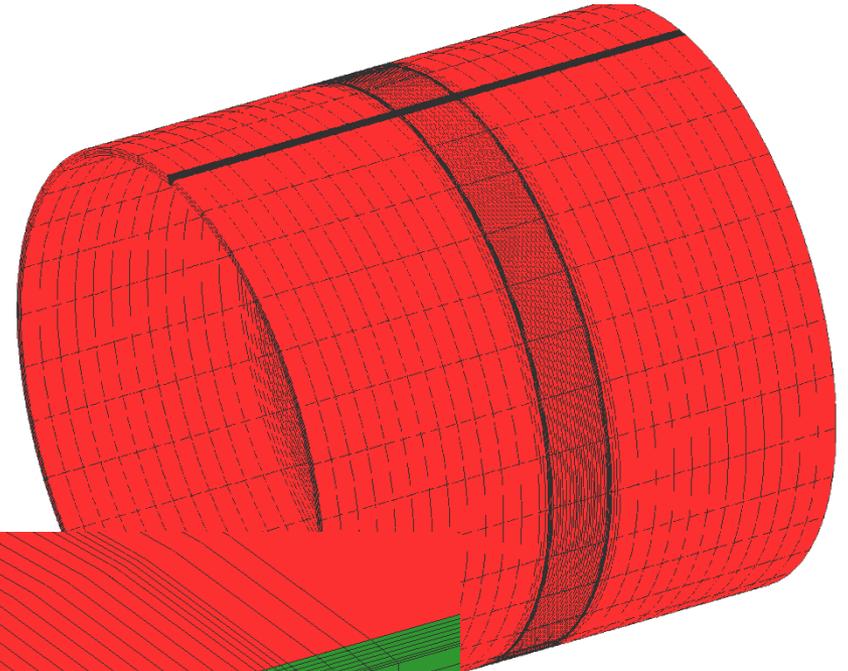
Downstream



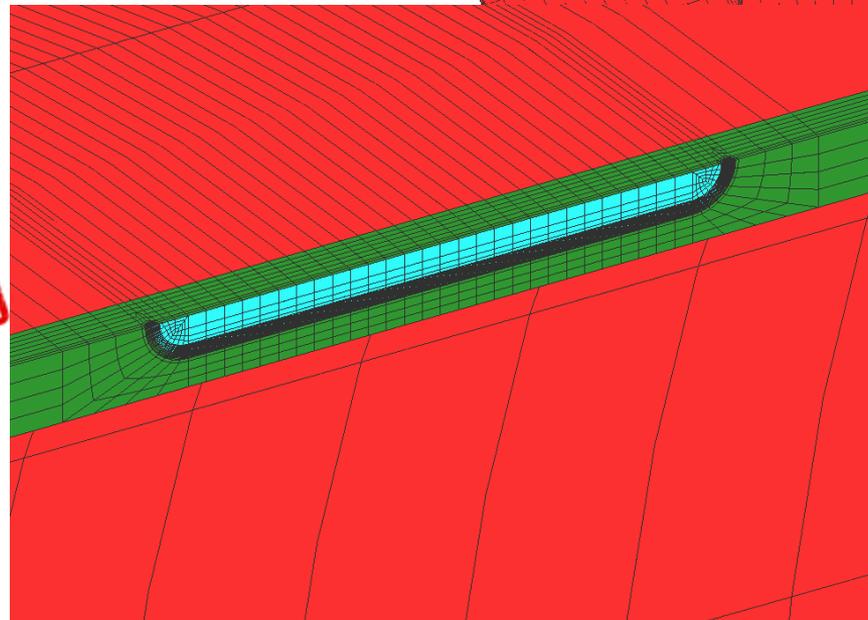
- The pipeline industry is out of step with the rest of the oil & gas industry with respect to assessing seam weld cracks.

New PRCI Method for Seam Weld Cracks

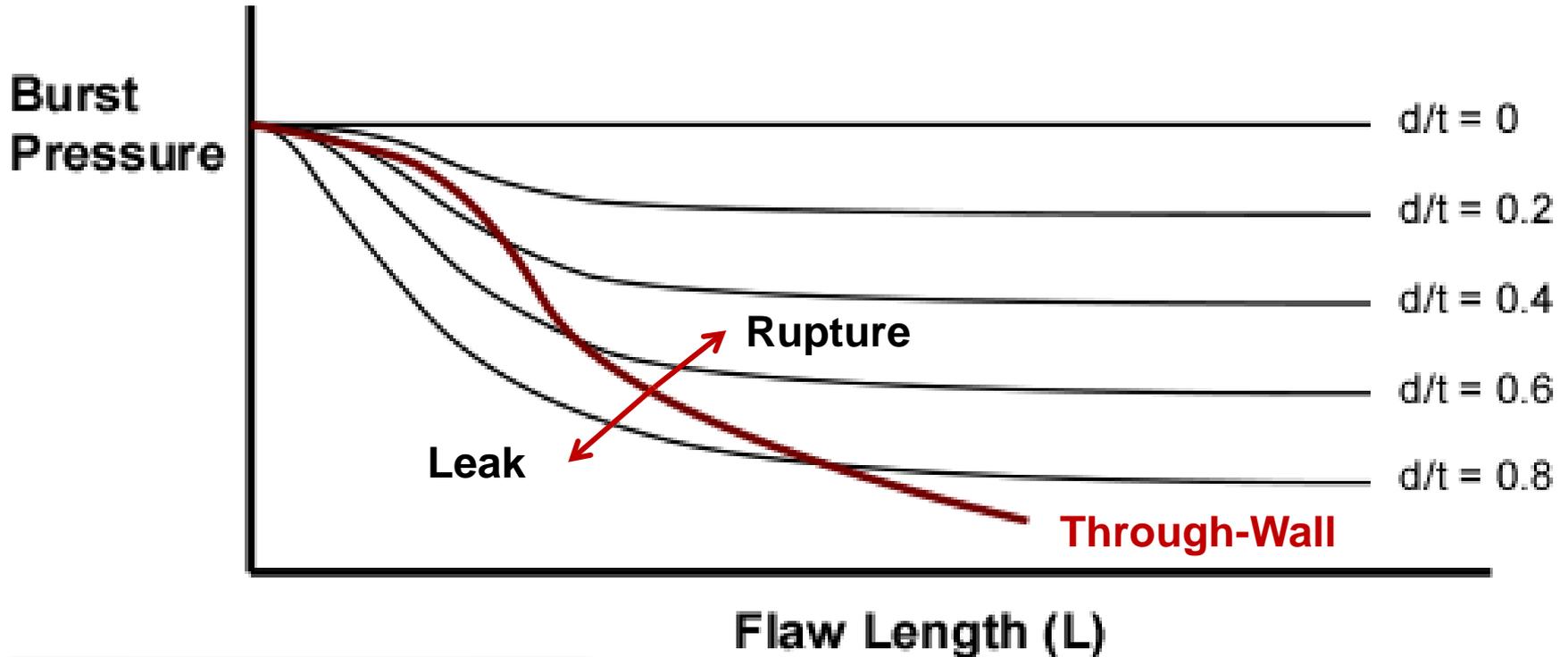
- Curve fits to elastic-plastic finite element analyses of axial cracks in pipelines.
- FEA results can be plotted in FAD coordinates.



COMING SOON



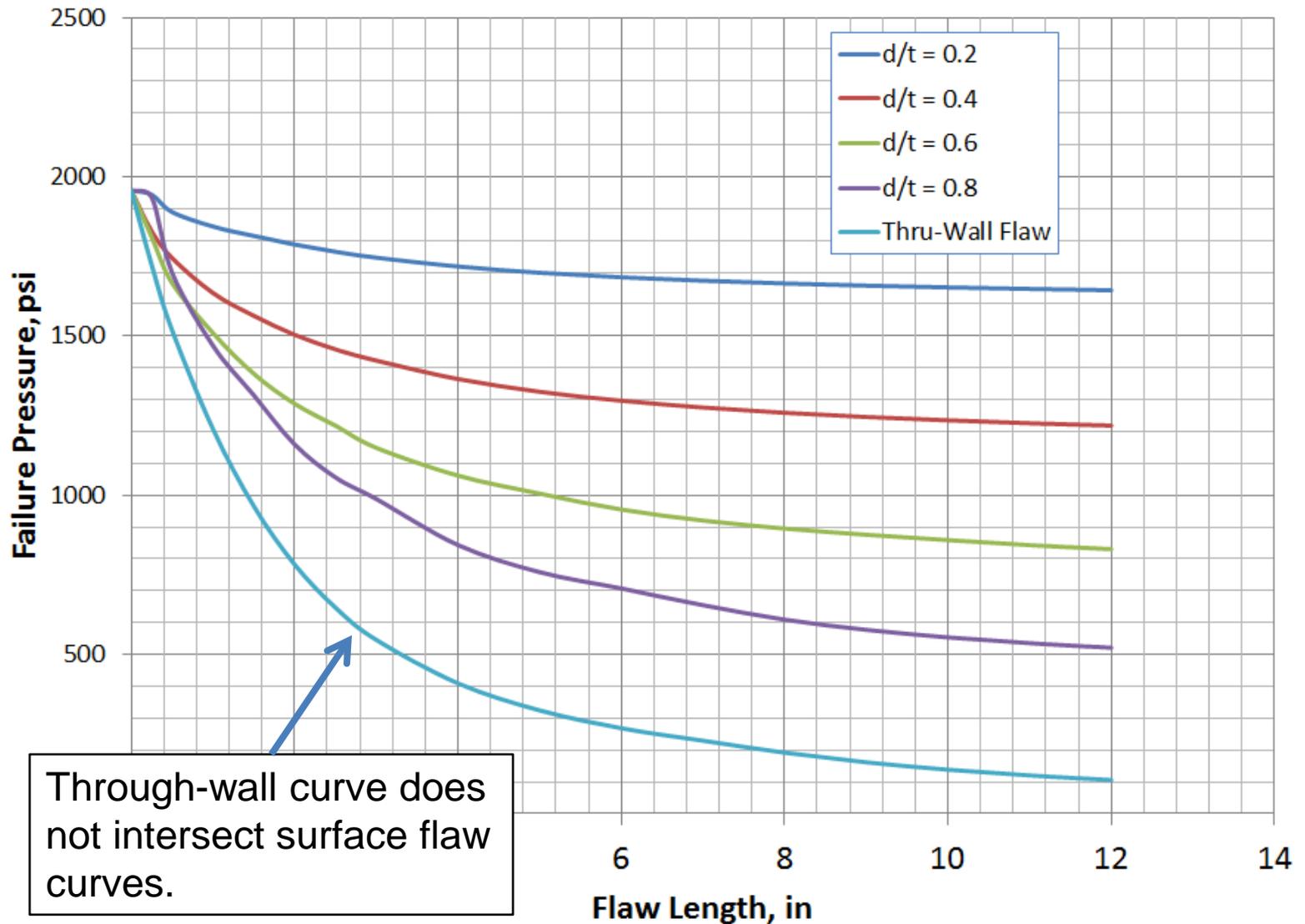
Myth #2: Leak/Rupture Curves



Ligament failure at short, deep flaw.

Burst Pressure Versus Flaw Length

API 579 FAD Method



Through-wall curve does not intersect surface flaw curves.

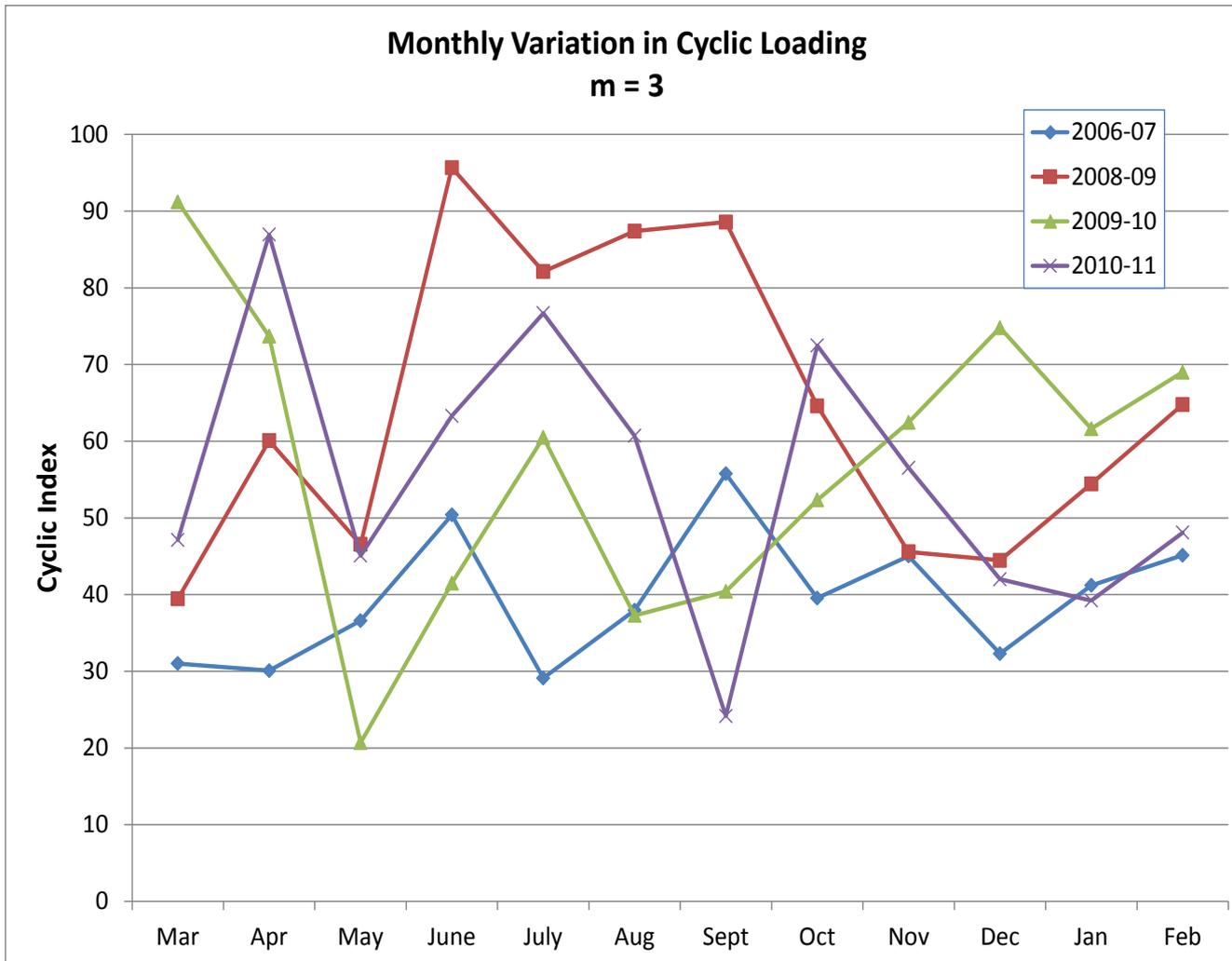
Myth #3: TT05 Cyclic Severity Rating

TT05 – Annual Cycles

Percent SMYS	Very Aggressive	Aggressive	Moderate	Light
72%	20	4	1	0
65%	40	8	2	0
55%	100	25	10	0
45%	500	125	50	25
35%	1000	250	100	50
25%	2000	500	200	100
Total	3660	912	363	175

- The four categories are subjective.
- Fatigue crack growth rate is driven by the absolute magnitude of cyclic hoop stress, not stress normalized by SMYS.

Alternative: Cyclic Index



- Defined as the equivalent full-MAOP cycles per year in X52 pipe.
- Can be viewed as a “pressure cycle speedometer.”

Cyclic Index for TT05 Categories

Cyclic Index

Pipe Grade	Very Aggressive	Aggressive	Moderate	Mild
A25	48	12	4	2
B	130	32	12	5
X42	219	53	21	8
X52	415	101	39	16
X60	636	155	60	25
X70	1013	247	95	39
X80	1521	371	143	59

- Pressure cycling that is considered “aggressive” in X42 is rated as “mild” in X80, despite the fact that the fatigue damage would be identical in the two pipe grades.

