Using POE as a Way of Quantifying Probability of Failure

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Managing Challenges with Pipeline Seam Welds

Working Group 3: Identifying Gaps with Assessment Methods

Kiefner & Associates incorporated

Issues for Assessing Seam Anomalies

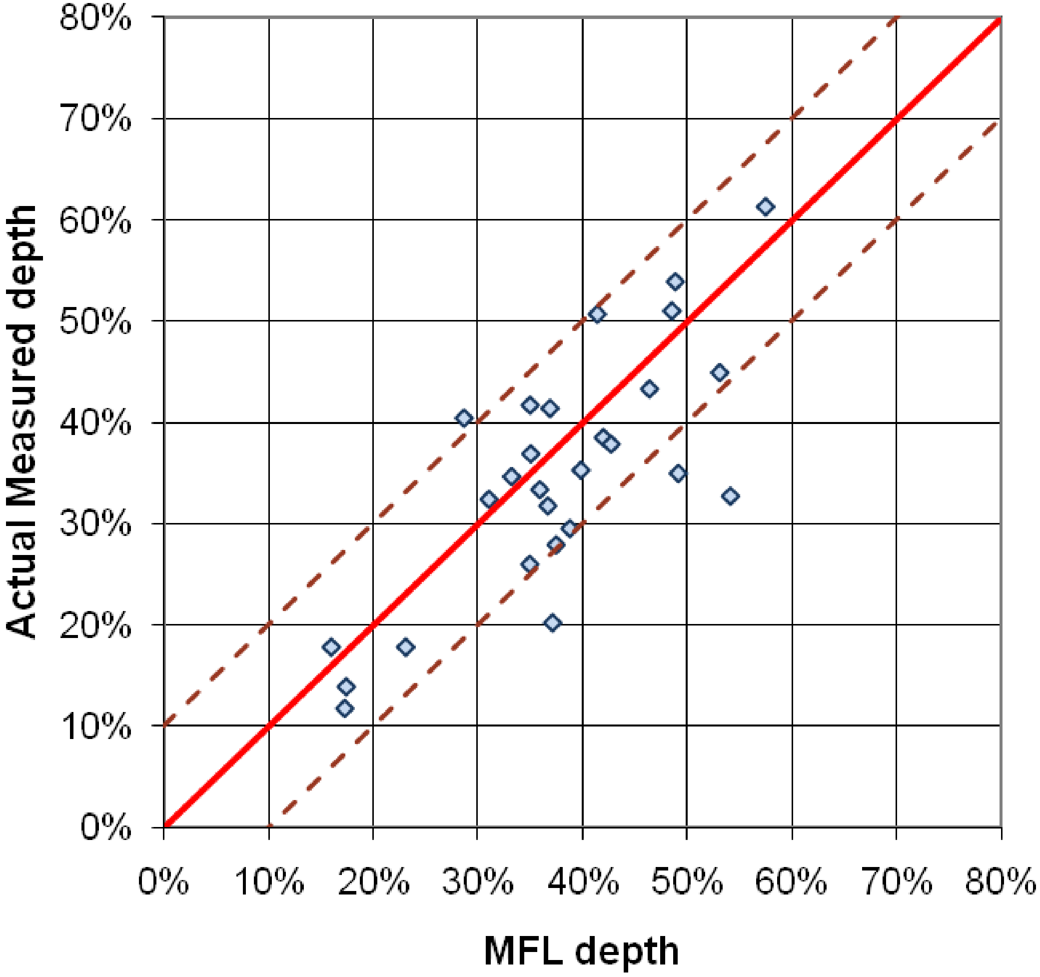
- Pressure Testing
  - After test is complete the risk is:
    - probability of pressure reversal
- In Line Inspection (ILI)
  - After testing the risks are:
    - Probability of Detection
      - Is a defect missed?
    - Probability of Identification
      - Are defects and benign anomalies correctly discriminated?
    - Sizing Error
      - Are the depth and length properly sized and accounted for?
- Sizing Error is directly related to probability of exceeding a safe threshold (POE)

Probability of Exceedance (POE) Analysis for Corrosion

- *PoE:* Probability of exceedance, the probability that actual severity of an indicated anomaly exceeds safe threshold
- Statistical basis for determining probability of failure
- Probability that $Depth_{ILI}$ > 80% wt
  (probability of "leak")
- Probability that P_{burst} < 1.1* MOP (or abnormal operating pressure)
  P_{burst} (calculated using called depth and length)

Kiefner&Associates incorporated

Unity Plot



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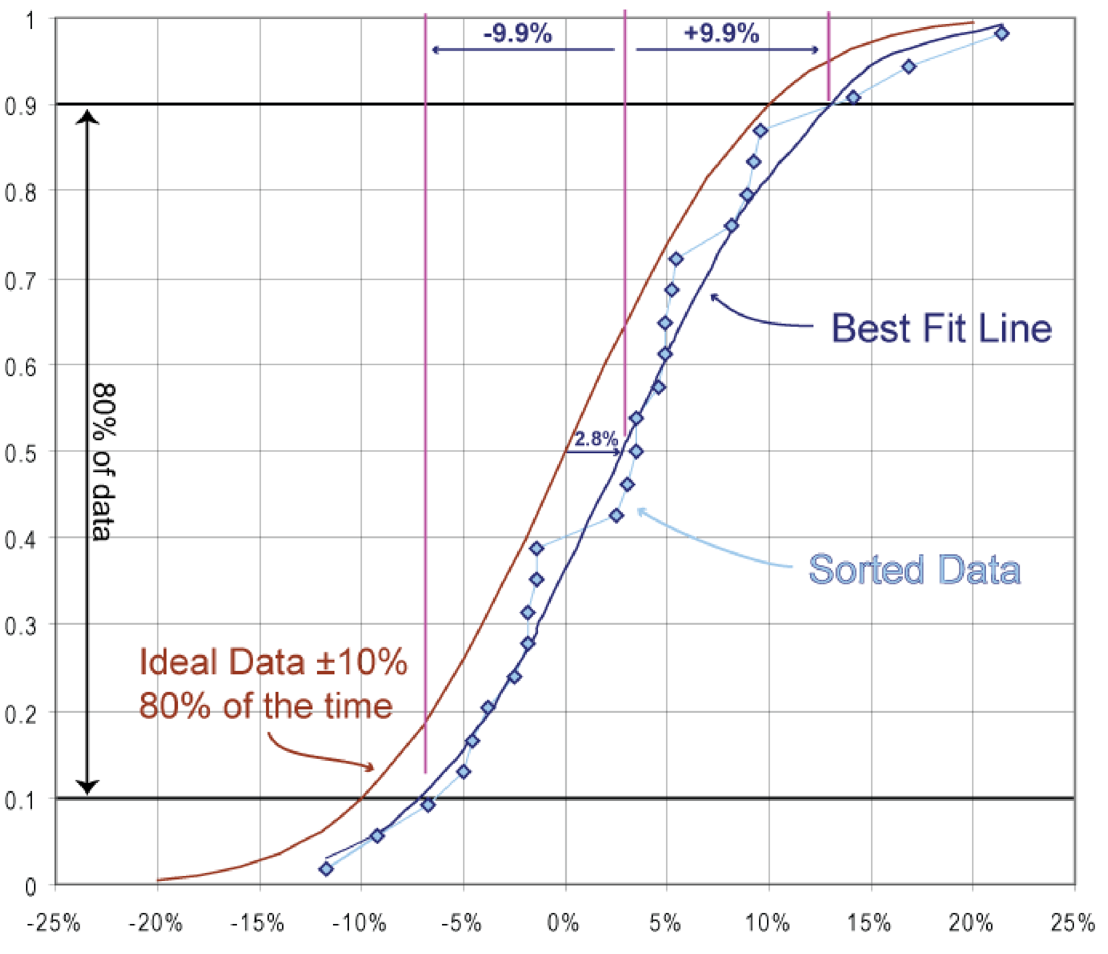
CUMMULATIVE DISTRIBUTION PLOT
MFL Depth – Actual Depth

Mean = 2.8%

St Dev = ±7.8%

80% Err = ±9.9%

data points = 27



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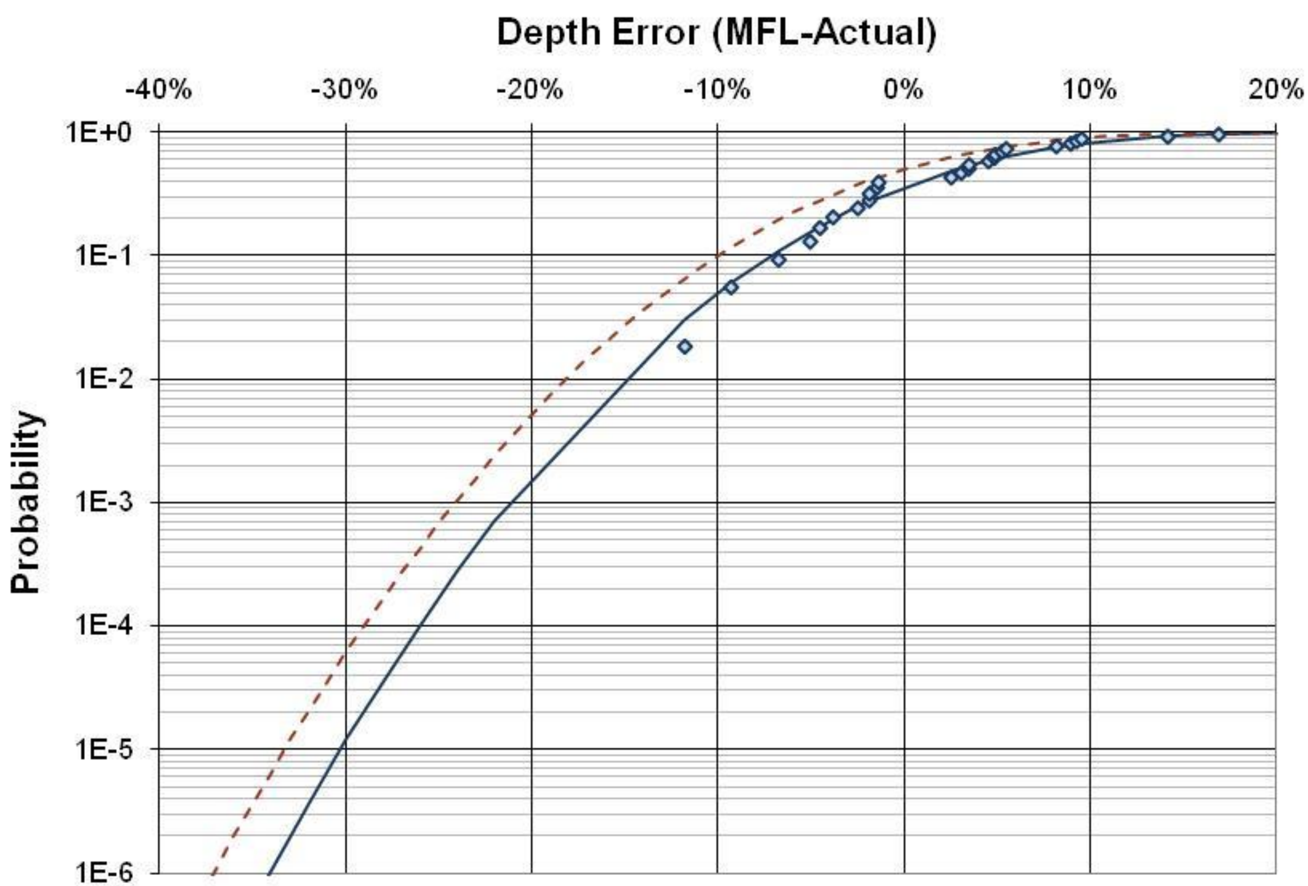
Logarithmic Plot

for extrapolating to small probabilities

POE	wt margin
10^{-3}	21%
10^{-4}	26%
10^{-5}	30%



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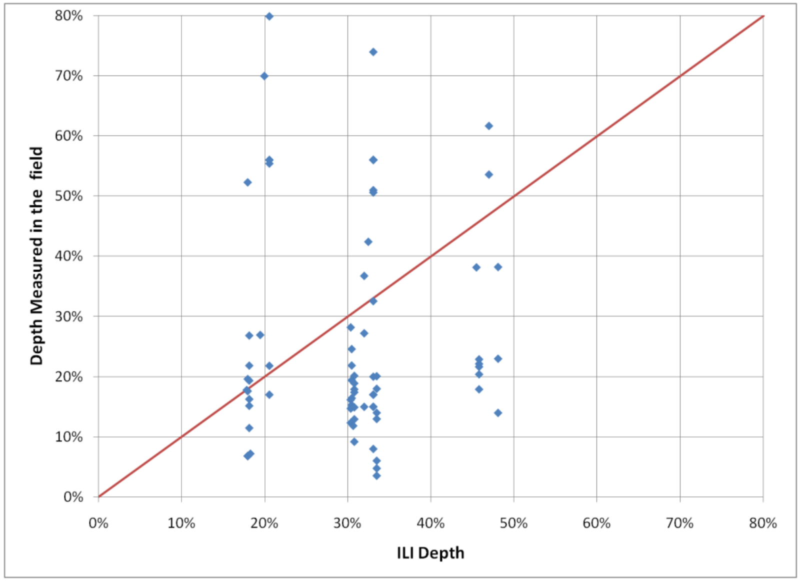
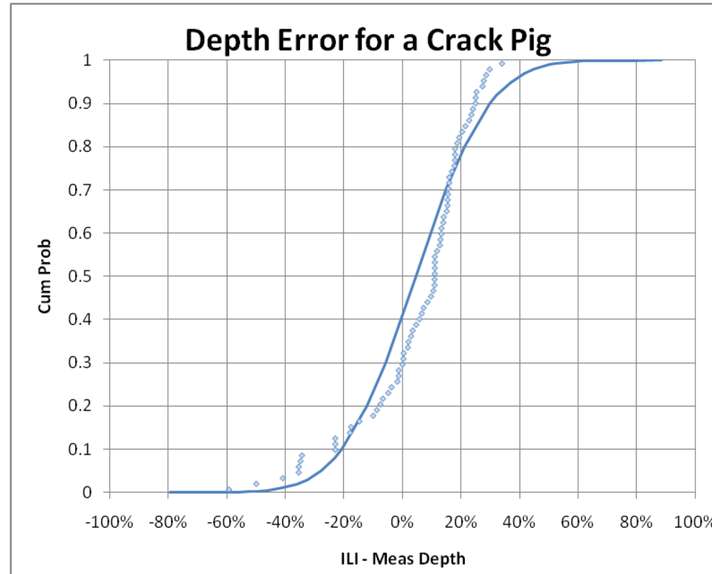
Probability of Exceedance (PoE) Analysis of Corrosion

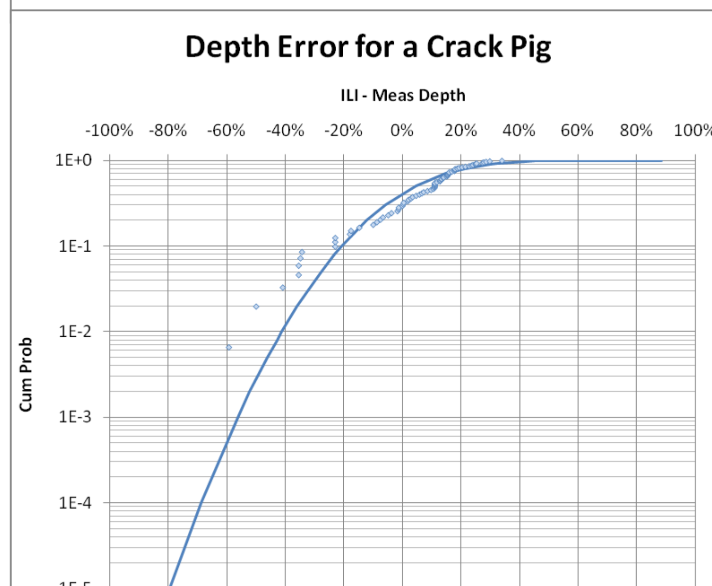
- Statistical basis for prioritizing response
- Defensible rationale for continuing or terminating response
- Optimizes cost-benefit
- Can be incorporated into risk assessment program
- Similar to what is normally done by judgment

POE for a Crack Tool Run

(a recent example)







# points	76
mean	4.5%
st dev	19.7%
80% error	25.2%

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POE for a UT Crack ILI Run

POE	wt margin
10^{-3}	56%
10^{-4}	69%
10^{-5}	79%

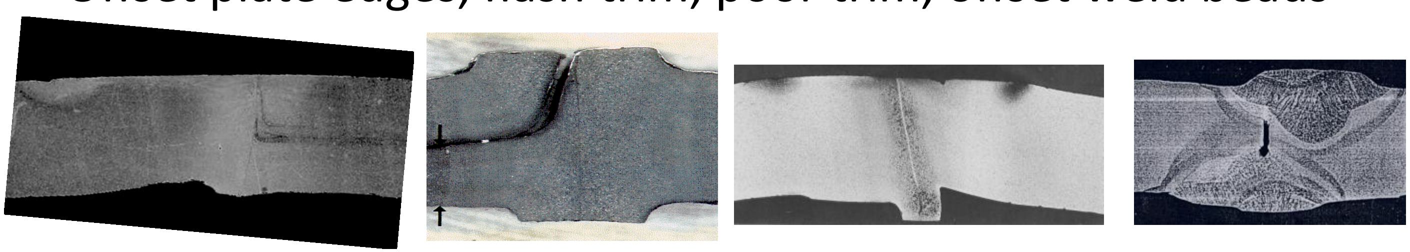
- Measurement error is large
  - Error is from both ILI and in-ditch measurement
  - Cannot tell which is the larger error component
  - Only way to be certain of depth is destructive analysis in the lab
- Previous slide shows poor fit of normal distribution
  - POE margins for 0.001, 0.0001, and 0.00001 for a normal distribution best fit are 56%, 69%, and 79% respectively
  - Extrapolation of actual data shows larger margins of safety are needed for cracks than for typical corrosion ILI runs
- This is just a single example
  - Other ILI crack tool runs and in-the-ditch data may produce better results.

Wish List

- More accurate ILI tools

  Uncertainty of ± 10% of wall (or ± ½ mm for 0.200-in wt)

- More accurate in-the-ditch measurements
  – Same or better accuracy as ILI tools
- Better discrimination (and allowance for irregular wall shapes)
  – Most defects for seam issues are located in the seam where other benign anomalies are occurring
    - Offset plate edges, flash trim, poor trim, offset weld beads



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