



280. Lessons Learned Using API 1163 for Metal-Loss ILIs

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Lessons Learned Using API 1163 for Metal-Loss ILIs

- This paper presents 100 metal-loss ILI validations using the Level 2 requirements of API 1163 (third edition)
 - Also discusses Level 3 results and provides guidance related to terms not fully defined in API 1163 (see paper for details)
- The paper shows the Level 2 validation requirements in the third edition of API 1163 are more stringent than in the second edition, which could lead to more validation digs and measurements
- Suggestions are made for reducing the number of required validation measurements

API 1163 Editions

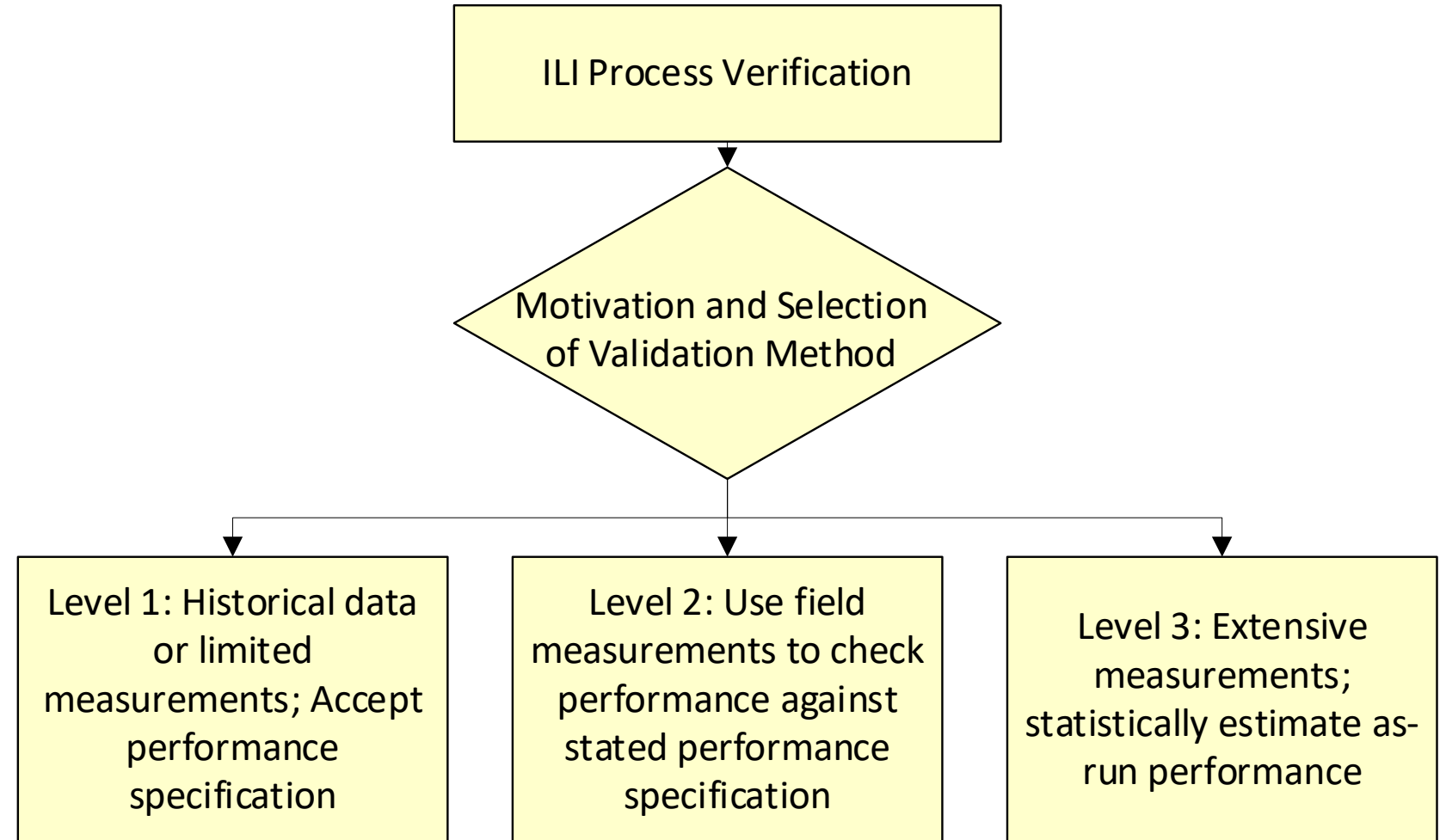
- API 1163, originally issued in 2005, has evolved through two later editions (2013 and 2021)
 - The 2nd edition, which is referenced in the U.S. Code of Federal Regulations Title 49, Part 192 and Part 195, provides ILI validation guidelines in an appendix (annex)
- The 3rd edition made many of the ILI validation guidelines in the 2nd edition mandatory, thereby making the standard more prescriptive
 - The 3rd edition provides explicit requirements for Level 1, Level 2, and Level 3 ILI system validations

PRCI Project IM 1-06A

- Subsequently, PRCI developed a guidance document and spreadsheet for conducting validations under the third edition of API 1163
 - The document and spreadsheet are gaining widespread use in the pipeline and inspection industries
 - Revisions of the PRCI documents are underway and expected to finish in 2025

API 1163 Validation Levels

- API 1163 provides three validation levels, with increasingly more complex requirements
- This paper covers Level 2 and 3 validations



Level 2 Validation Requirements

- API 1163 Level 2 validations are based on null hypothesis testing
 - The null hypothesis is that the ILI met its performance specification
 - The testing assesses whether there is enough evidence to reject the null hypothesis
- In the PRCI document and spreadsheet and in API 1163, guidance is provided to help the user judge whether the performance specification could or should be accepted

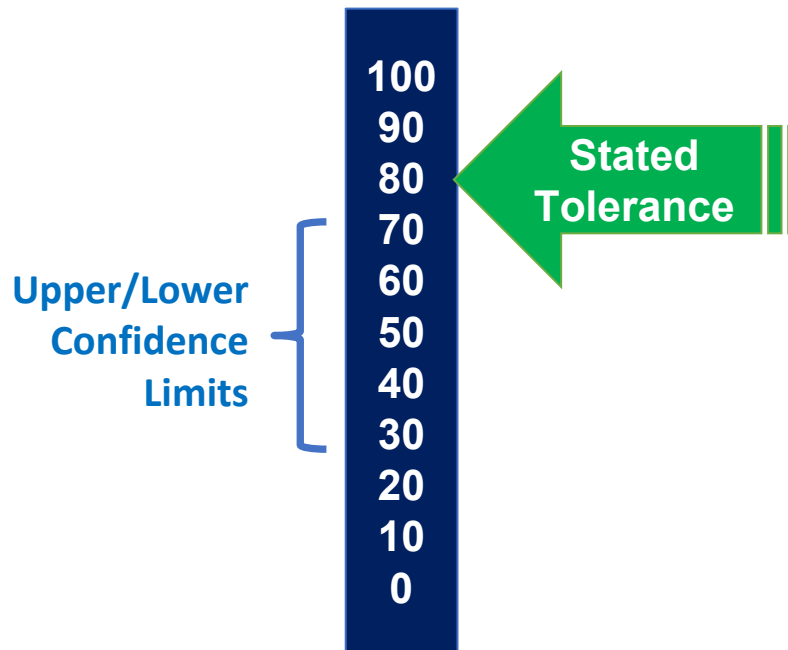
Level 2 Validation Outcomes

- In Level 2 validations, assessments are assigned one of three “Outcomes” that determine whether the ILI is
 - Rejected (Outcome 1),
 - Further evaluated (Outcome 2), or
 - Exceeded (Outcome 3)
- These outcomes depend on where an estimated range of actual certainties falls relative to the performance specification given by the ILI service provider

Outcomes 1, 2, and 3

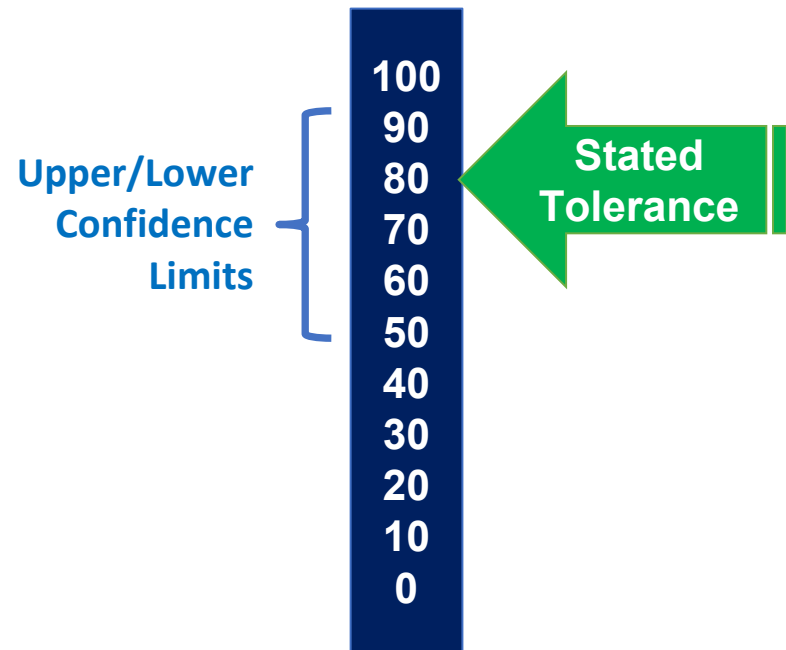
Outcome 1 (Reject)

Certainty Scale



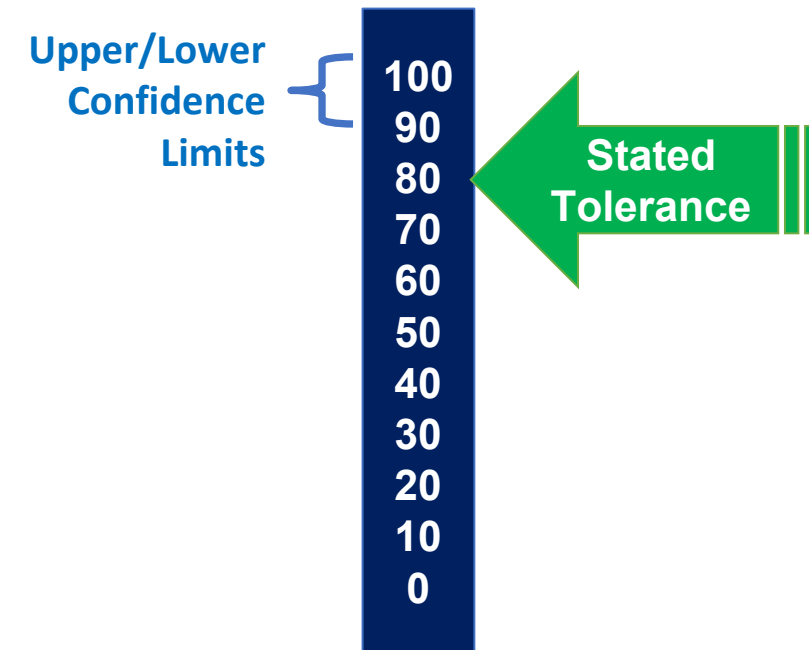
Outcome 2 (Evaluate)

Certainty Scale



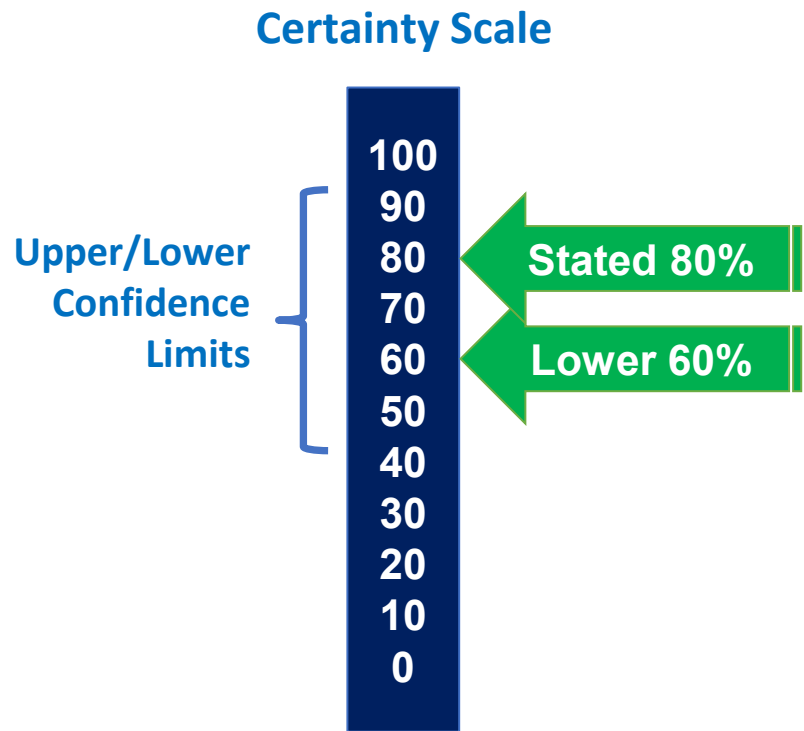
Outcome 3 (Exceed)

Certainty Scale

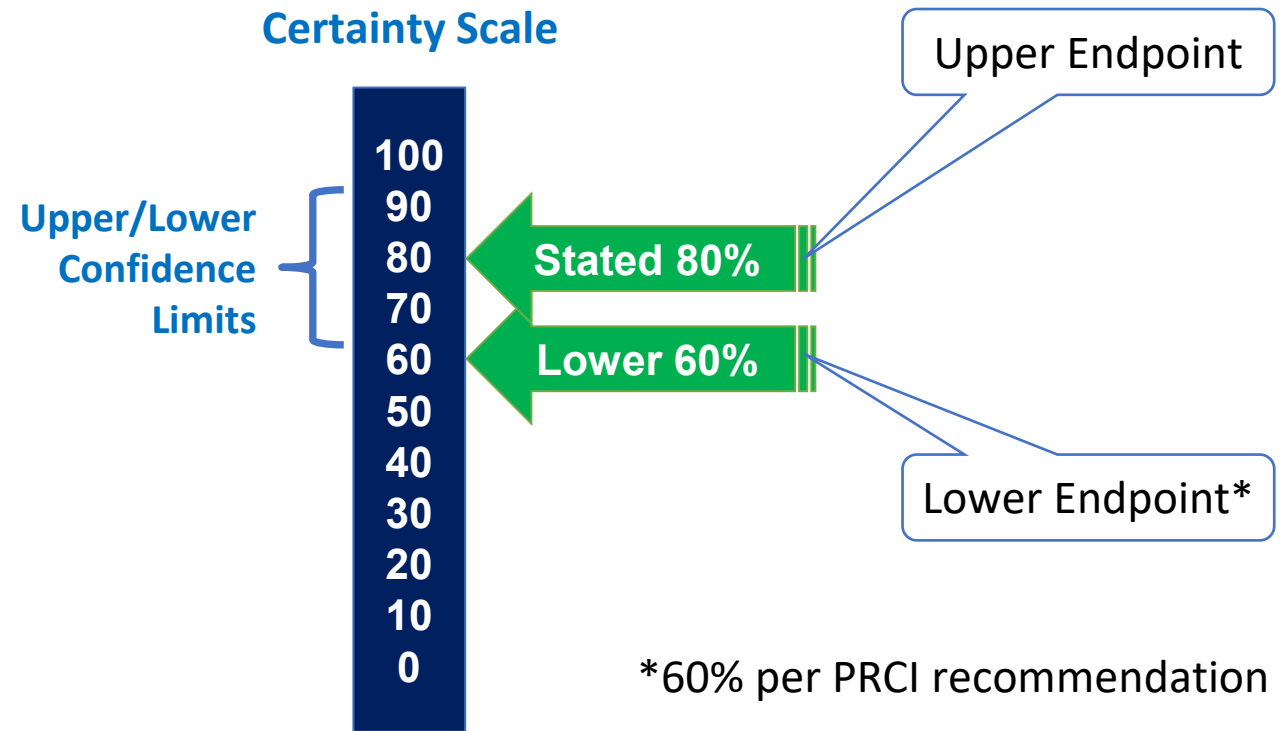


Outcome 2 – Pass/Fail (Based on Upper and Lower Endpoint)

Outcome 2 (Fail)



Outcome 2 (Pass)



*60% per PRCI recommendation

100 Case Studies

- Level 2 validations were conducted using the PRCI guidance document and spreadsheet with minimal modifications necessary to accommodate the number of field measurements for each case
- The case studies involve actual ILI surveys previously performed by pipeline operators between about 2010 and present
- The number of field measurements per inspection ranged from a handful into the thousands

Results

- Several types of validation results were obtained:
 - The number of field depth measurements did not meet the requirements of API 1163
 - The remainder produced one of the three outcomes (Outcome 1, Outcome 2 fail, Outcome 2 pass, or Outcome 3)
 - For Outcome 2, which calls for further evaluation, the validation either passed or failed the recommendations included in the PRCI guidance document and spreadsheet

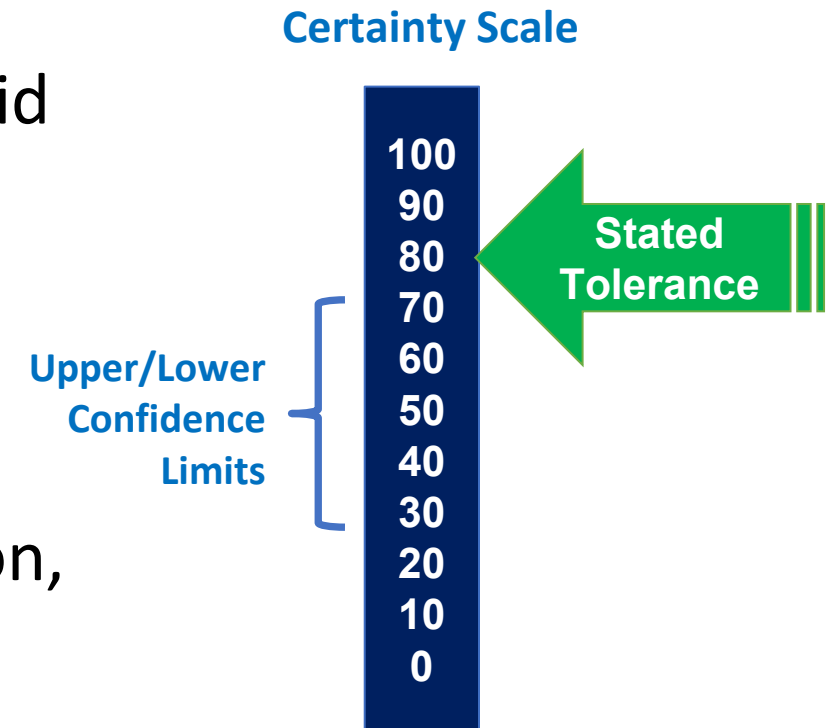
Insufficient Data for Analysis

- 13 of the cases had fewer than 6 field measurements (the minimum number needed to just pass a Level 2 validation)
- These cases could be candidates for a Level 1 validation if the worst reported anomaly was not significant in the pipeline operator's judgment or if the operator has extensive experience using the ILI system on the same or similar pipelines
- Otherwise, more field measurements would be needed to conduct an API 1163 validation

Outcome 1 (Reject)

- 40 of the cases produced Outcome 1, which indicates there is statistical evidence the ILI did not meet its performance specification
- All these cases failed the upper endpoint criterion, and all but six failed the lower endpoint criterion
- An approach to performing a Level 2 validation, not discussed in API 1163 or the PRCI documents, is to artificially increase the ILI tolerance until the validation passes Level 2

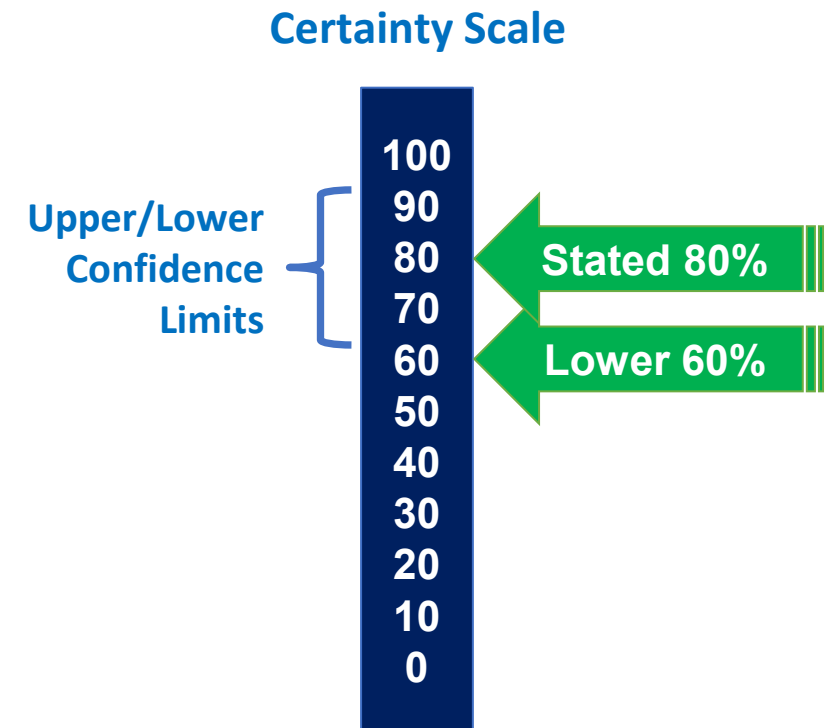
Outcome 1 (Reject)



Outcome 2 (Evaluate)

- 44 of the cases produced Outcome 2, which calls for further evaluation
 - Slightly less than half of these cases (19) failed the lower endpoint criterion - some might have benefited from additional validation measurements
- The remainder passed both endpoint criteria
 - Passing the upper and lower endpoint criteria allows use of the ILI's stated tolerance

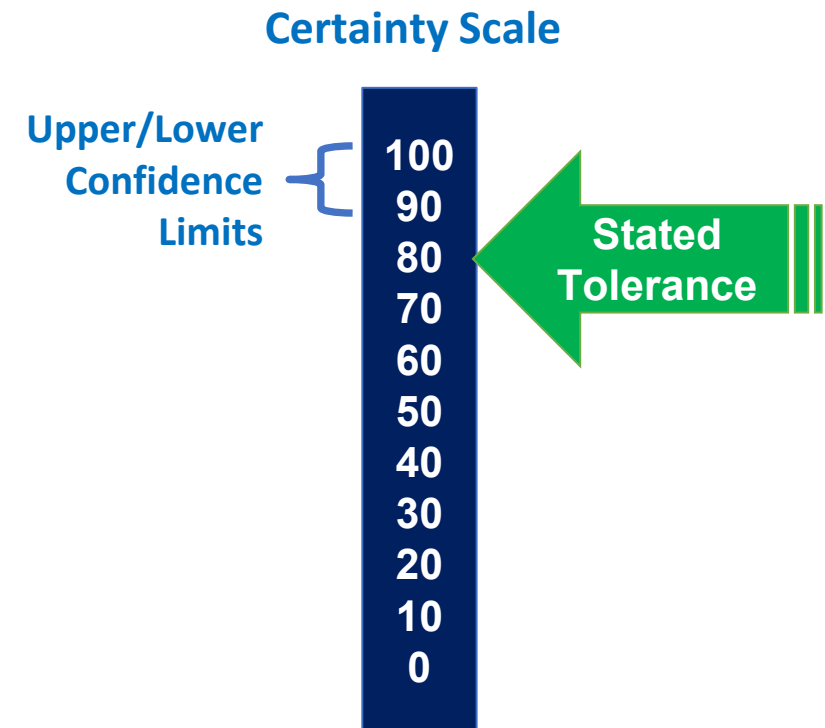
Outcome 2 (Pass)



Outcome 3 (Exceed)

- Only three cases reached Outcome 3, where the validation demonstrates that the ILI exceeded its stated tolerance
 - Using either the tolerance needed to pass Outcome 2 or the Level 3 tolerances could provide the basis for using tighter tolerances in integrity decision-making

Outcome 3 (Exceed)

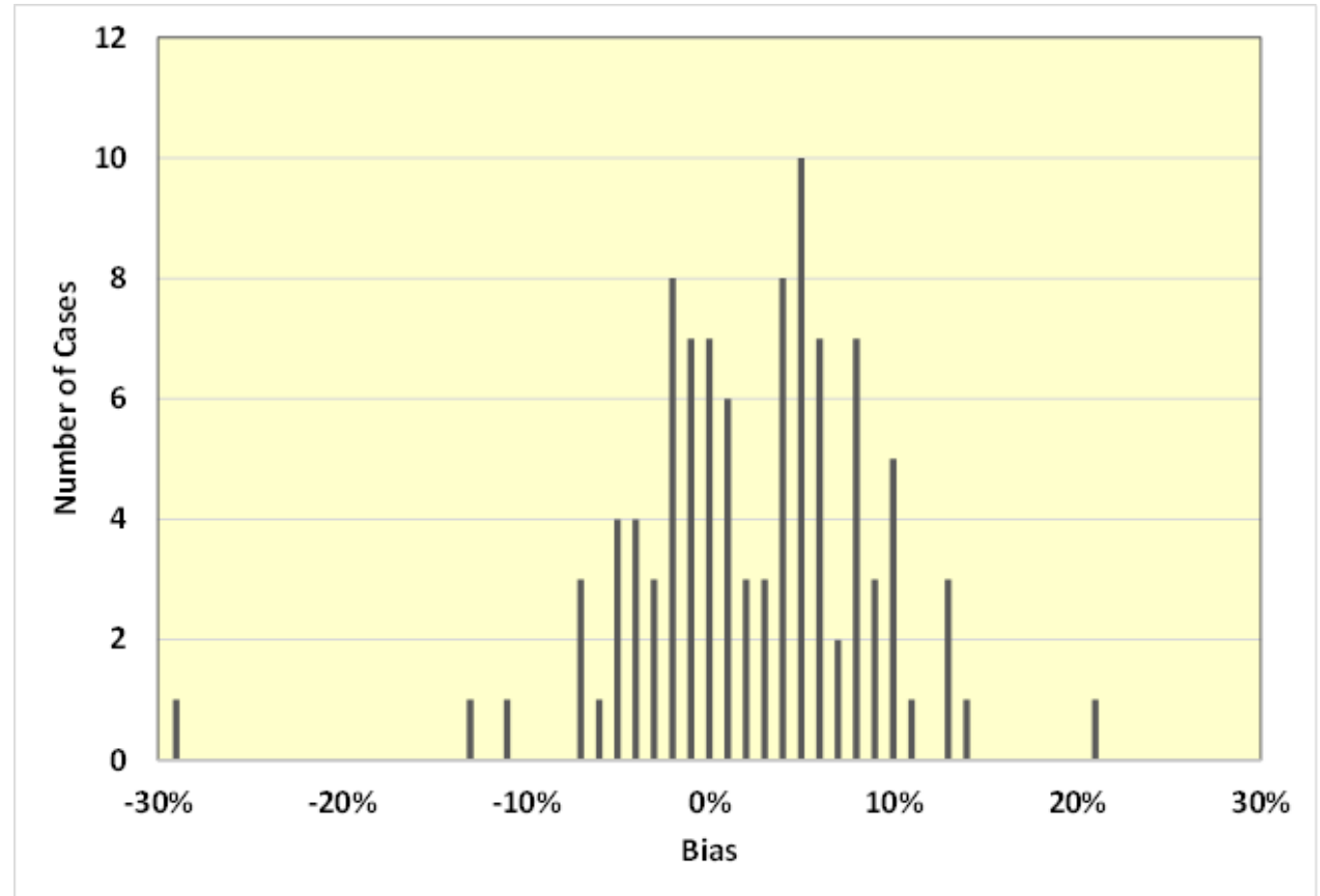


Level 3 Validations

- Level 3 validations, as included in the PRCI guidelines and spreadsheet and API 1163, allow the user to estimate the actual ILI performance
 - The PRCI guidelines recommend at least 10 validation measurements for Level 3, up from six needed for a Level 2 evaluation
 - Level 3 validations provide information on biases and tolerances

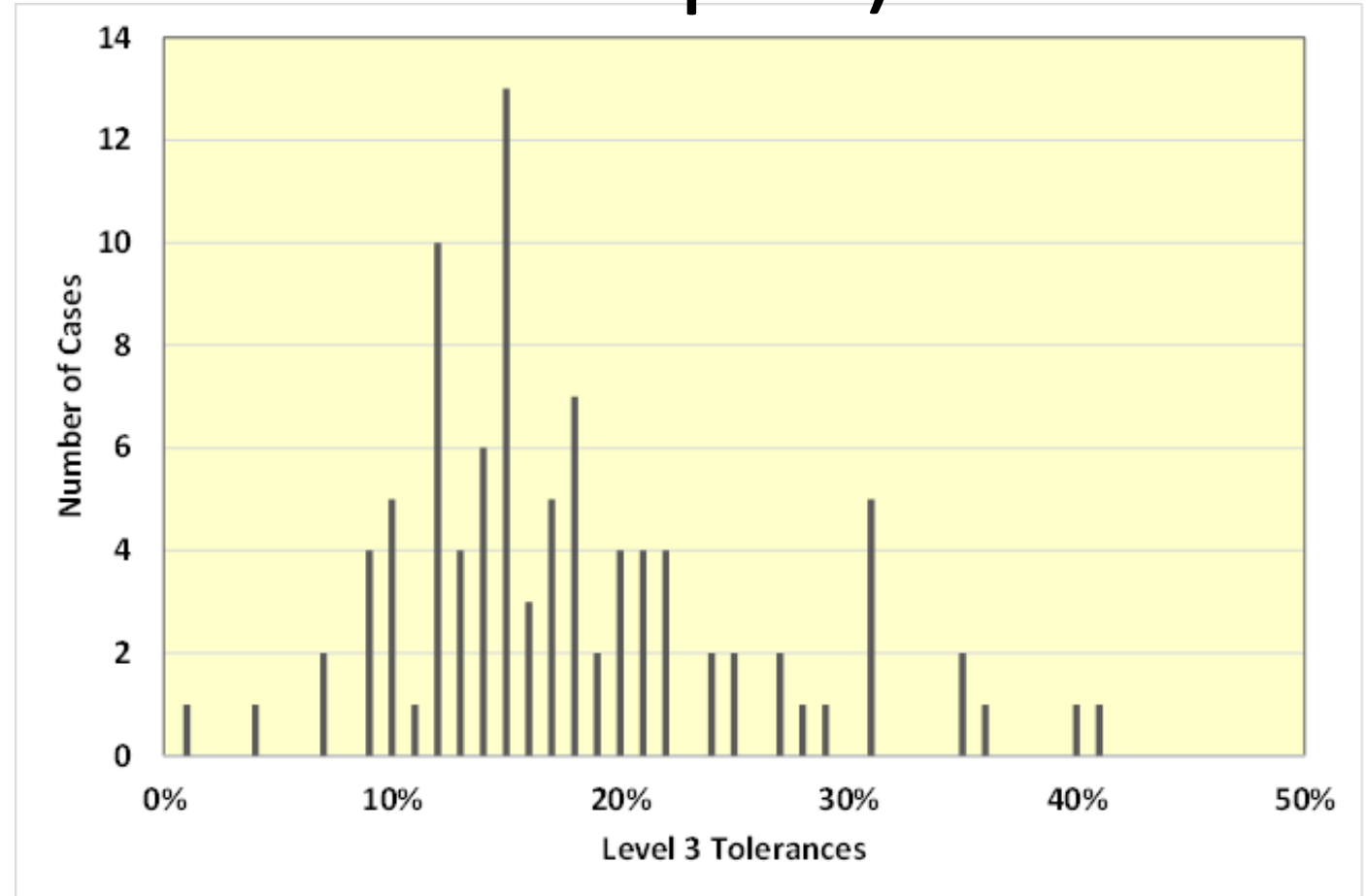
Biases Associated with Test Cases

- Combined, the mean bias was about 2% (undercall)
- Some inspections, including several with over a thousand data points, showed biases above 10%
- In the authors' experience, biases more than 10% WT are unusual



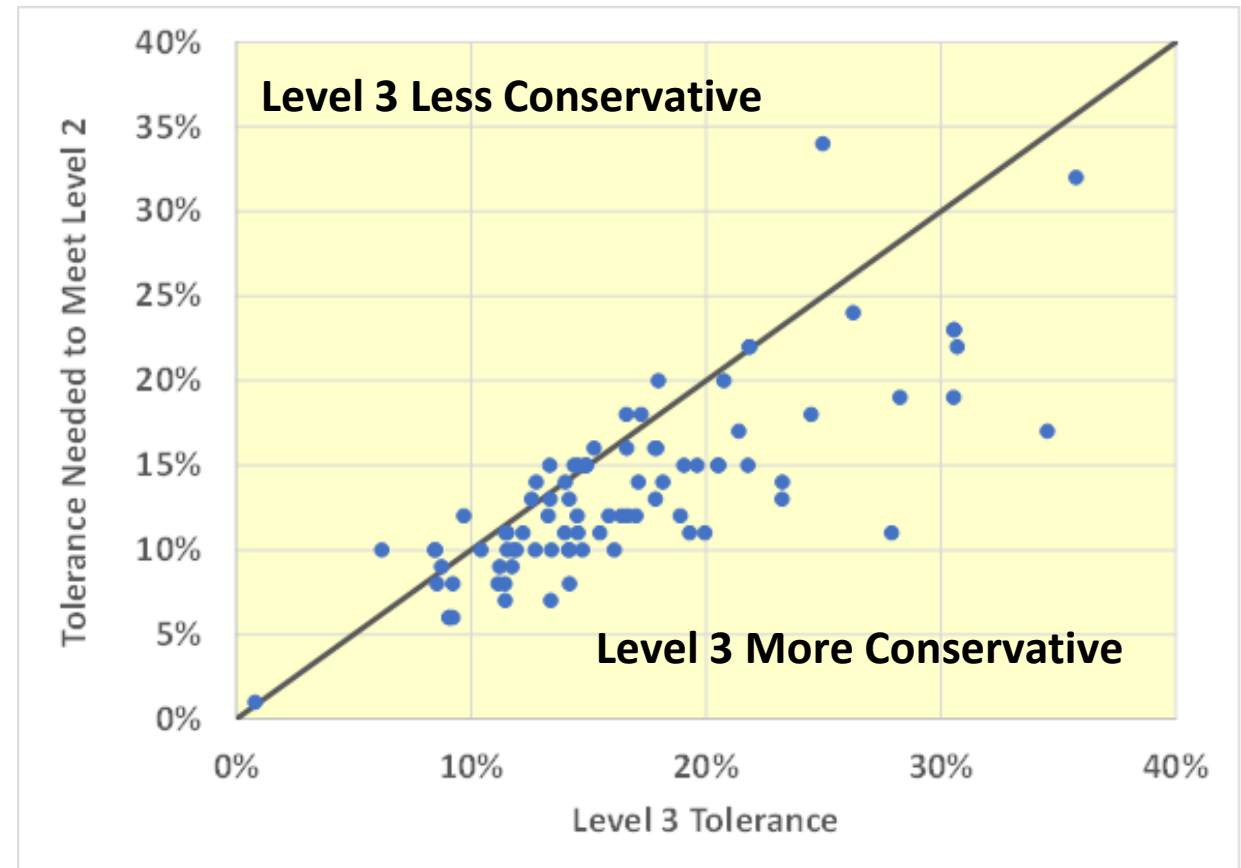
Level 3 Tolerances (Tolerances $\geq 50\%$ omitted from plot)

- Level 3 tolerances were generally larger, sometimes much larger, than +/-10% WT
- The largest Level 3 tolerances corresponded to cases with smaller number of data points
- Most fell between 10% and 20% WT



Level 3 Tolerances versus Tolerances Needed to Pass Level 2 Validation

- The Level 3 tolerances tended to be larger than the tolerances needed to pass a Level 2 validation
- Consequently, the Level 3 tolerances are more conservative and may require additional remediation digs than the tolerances needed to pass a Level 2 validation



Summary

- 100 data sets were assembled and used to evaluate the Level 1, 2, and 3 validation approaches given in API 1163 (third edition)
- 13 cases had less than six field measurements, the minimum needed for Level 2 assessment, suggesting that additional field data is needed
- 40 Level 2 validations resulted in Outcome 1 (validation failed), where there is statistically significant evidence the ILI did not meet the performance specification
- Higher tolerances could be used to change Outcome 1 to Outcome 2, thereby allowing the inspection to be validated

Summary (Continued)

- 44 cases resulted in Outcome 2 (requiring further evaluation)
 - 19 failed the Level 2 lower endpoint criterion – using the tolerance needed to pass the Level 2 can provide a successful validation
 - 25 passed the Level 2 Outcome 2 lower and upper endpoint criteria, allowing the use of the stated tolerance (+/-10% WT)
- 3 cases resulted in Outcome 3 (validation demonstrated the ILI tolerance was likely met)
- Level 3 validation tolerances offer an alternative to the Level 2 tolerances, but they are often larger than the tolerances needed to meet a Level 2 validation

Conclusions

- The third edition of API 1163 is more stringent than the second edition and can force a company to use higher tolerances in integrity decision-making
 - Out of the 100 case studies, 72 did not pass Level 2 validation
- Using the tolerance needed to meet a Level 2 validation can allow ILI validation using a lower tolerance than provided in the Level 2 “equivalent tolerance” or the Level 3 tolerances
- Using lower tolerances can reduce the number of remediation digs / field measurements

Thank you for listening!

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