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VALIDATION OF ILI PERFORMANCE, THE IMPORTANCE OF ILI VALIDATION IN THE ENERGY TRANSITION TO HYDROGEN FUELS

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ABSTRACT

Validation of ILI performance is a critical component of any in-line inspection campaign to ensure that the ILI performance specification has been achieved. This allows high confidence integrity decisions to be made using the ILI data. The issues posed by the energy transition and the introduction of Hydrogen into existing gas networks present acute challenges for the accurate sizing of crack-like features and the subsequent validation of ILI performance in accordance with API 1163.

This paper discusses the current challenges of validating crack-like defects and the implications of the current industry practice with regards to the requirements of the Hydrogen transition.

Keywords: ILI, validation, hydrogen, energy transition, NDT, competence, quality

1. INTRODUCTION

In-line inspection (ILI) tools can measure a range of different defect types with a high degree of accuracy especially considering the harsh environments that the tools operate in. However, there are occasions when the specification of the tool can not be met due to the operating conditions, feature specific morphology and other factors. It is essential therefore to understand if the tool has performed within its specification on a run by run basis. In the US this is a legal requirement under PHMSA, but is seen as best practice in most other countries around the world.

Validation of crack like defects is a manual process which is significantly influenced by the procedure utilised and the skill and experience of the in-field operator. Significant variability can therefore be seen in the tolerances of these inspections which has significant implications on the validation of the ILI tool.

The introduction of Hydrogen into the gas networks will reduce the critical flaw size of crack-like indications due to the potential embrittlement of the material. The inclusion of additional uncertainty in the ILI tolerance could be detrimental to the integrity of the pipeline network.

If in-field verification of an unknown quality is used to validate the ILI for hydrogen conversion pipelines, the additional uncertainty that can be attributed to crack sizing of unknow quality can be significant enough to cause failure in a number of features in cross country pipelines.

2. ILI VALIDATION

Despite advances in technology, ILI validation is still a very manual process and the tolerances associated with each feature are significantly influenced by user skill and experience as well as technology selected. User variance is most significant in crack sizing where there are a number of different technologies that have the capability to size cracks all with pros and cons for various morphologies and combined feature types.

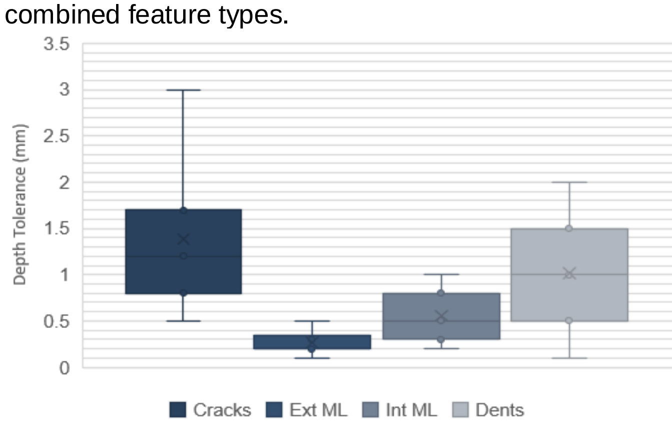

FIGURE 1: Potential tolerances of various feature types

However, independent user tolerance is rarely known in in-service inspections due to the variability and challenges with understanding system performance.

Therefore conservative tolerances should be adopted, like the ones seen in BS 7910. These are fine to use for individual integrity assessments as the conservative nature of the measurement means that safe repair options will be utilised. However applying these conservative tolerances to ILI validation measurements puts a significant amount of uncertainty in the ILI measurement. A ±3 mm tolerance for shear wave UT is recommended by BS 7190 [1], which at a 1 mm detection threshold would make most features unacceptable in cross country hydrogen pipeline.

In order to reduce the tolerance of the in-field inspection, a blind trial is required to understand specific inspector tolerance using the chosen inspection system.

3. HYDROGEN EFFECT ON VALIDATION

The EPRG review on integrity assessment methods for hydrogen conversion [2] discusses how the tolerable crack dimensions are affected by the introduction of hydrogen into the gas networks with various charpy toughness's and are shown in Figure 2.

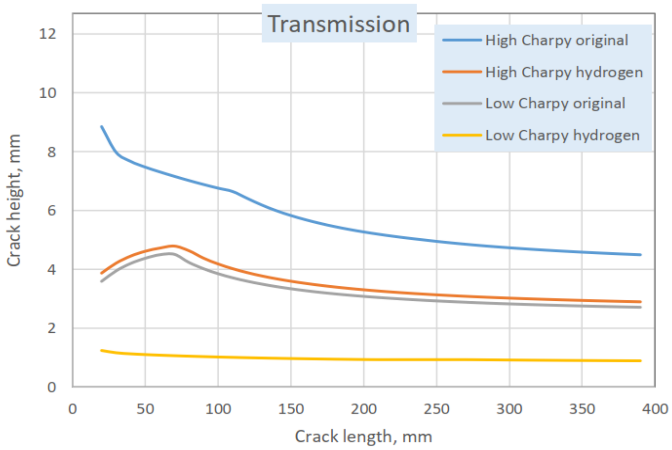

FIGURE 2: Tolerable seam weld axial cracks for transmission pipelines

The introduction of hydrogen will reduced the tolerable feature size for crack depths (especially for weld of low toughness's), which means that the confidence in the ILI tolerances are more important because there is less scope for uncertainty in the assessments.

4. VALIDATION TO API 1163

When validating ILI performance to API 1163 [3] a validated feature is considered within specification if the following criteria is met:

$$\delta e_{comb} = \sqrt{[\delta(\tfrac{d}{t})_{ILI}]^2 + [\delta(\tfrac{d}{t})_{FIELD}]^2} \qquad (1)$$

Equation 1 has numerous implications but the most significant in this instance is that bigger the in-field tolerance can result in a measurement which is acceptable, but inadvertently lowers the confidence in the ILI measurements.

Therefore a validation tolerance which has minimal influence (Ideally less than 10% of the stated ILI tolerance) on the combined tolerance is the only way to guarantee the ILI specification is representative of the validation.

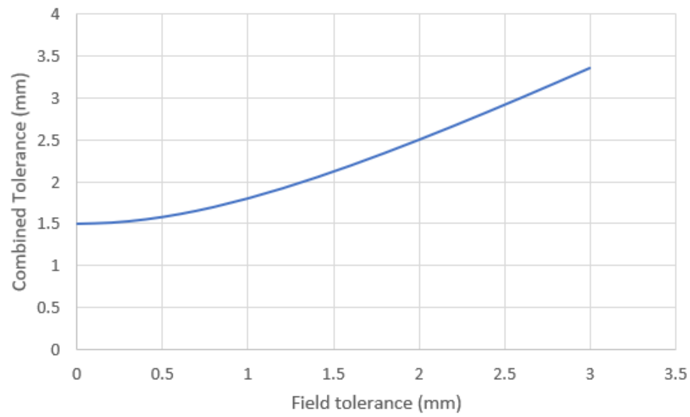

FIGURE 3: Influence of field tolerance on the combined tolerance

5. CONCLUSION

The introduction of Hydrogen into the gas network is going to reduce the tolerable crack size which means that having higher confidence in the ILI measurement and tolerance will become more critical to avoid failures. This can only be achieved in-field by understanding the tolerance of the individual inspectors and creating a small influence on the combined tolerance from API 1163. This can be accomplished by blind trials on individual inspectors.

REFERENCES

[1] British Standard, BS 7910, *Guide to methods for assessing the acceptability of flaws in metallic structures* 2022.

[2] EPRG, Project number 14223, *Integrity assessment method review*, 2022.

[3] API 1163, *In-line Inspection Systems Qualification*, 2021.