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Abstract Submitted for Oral Presentation

Inspection of Nuclear Assets with Limited Access

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Traditionally the inspection of nuclear containers and their welds, is highly challenging, time-consuming and expensive due to the complexities and logistics of the environment and process. This problem is further compounded when the asset lifetime is increased beyond their original design intent, and when accessibility to the asset is obstructed. One such problem being faced by Sellafield LTD in the UK is the storage of spent nuclear fuel for reprocessing, with government policy changing from favouring reprocessing to long term storage [1]. These assets are contained in thin 1.4404 stainless steel canisters with a Resistance Seam Weld (RSW) sealing the canister body to the lid. Additionally, the storage facilities only allow for partial circumferential access. This work is concerned with the development of an ultrasonic screening method of the RSW located on these canisters whilst in storage ("in-situ"). The work aims to make use of a Feature Guided Wave (FGW) that will transmit an ultrasonic wave confined only to the RSW that will allow screening of the full circumference from partial circumferential access.

Feature Guided Waves were initially discovered experimentally from work conducted at by BAE and Imperial College London [2], and further studied analytically and experimentally by Imperial College London & Nanyang Technical University [3]–[5]. This work leveraged the use of the Semi-Analytical-Finite-Element Method (SAFEM) to predict all wave modes that can exist within the cross section of a component. If the cross section of the component, contained a feature where the geometry is significantly different (i.e. a weld, a bend in a CFRP stiffener or a fin), filtering based on the properties of the wave modes predicted (e.g Axial Power Flow, Kinetic Energy etc.) can be performed to predict the existence of wave modes confined to this feature. Moreover, the wave modes can be classified based on their mode shape, to inform transduction choice. In this work, the SAFEM has been employed in conjunction with filtering to predict modes confined to the RSW in within the canister. An automatic classification technique has been developed to trace the dispersion relationships of the wave modes so that experimental validation can be obtained, and a screening method can be developed. Understanding the dispersion relationship of guided waves is of utmost importance, so that reliable and repeatable experimental results are obtained.

The SAFEM was employed on the resistance seam weld structure shown in Figure 1. The model was run from 50-1000kHz in 10kHz increments with over 8,000 wave modes being predicted at each frequency interval. A variation of the filter proposed by Yu et al. & Zuo et al. was employed on the results to reduce the number of wave modes to that only confined within the vicinity of the weld geometry [4], [6]. The resulting data set was traced automatically utilising a combination of orthogonal mode sorting and Padé expansion across the aforementioned frequency range [7], [8]. It is thought that this work is the first to automatically trace the dispersion relationship in this manner for this type of problem. Four modes were successfully traced that appear to offer promise for an initial NDT screening method. Current work is focusing on experimentally validating these modes and deploying an NDT screening regime based the previous simulations in both a lab based and industrial environment.

Figure 1 - RSW Geometry

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