Influencing parameters for inspection of austenitic welds

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Introduction: Stainless steel welded components are common in the nuclear sector and are being increasingly used in the oil and gas and petrochemical industries. Ultrasonic techniques are commonly used for NDT of these materials, as they provide volumetric coverage and are able to interrogate large component thicknesses and complex geometries which preclude radiographic techniques. However, the welds typically display an austenitic structure which is comprised of large, textured grains. This results in high scattering and beam distortion which vary depending on the welding position and preparation. This experimental study employs an extensive parametric investigation to identify best practice inspection methods for such materials and welds. Methodology: A range of 60mm thick, stainless steel calibration blocks containing manual metal arc welds were fabricated. These were interrogated using a 45° longitudinal wave, single crystal immersion technique with probe frequencies from 1-10MHz. Using a pulse-echo setup, backscattered noise from the weld and parent metal were measured. These were compared to reference reflectors at the weld centreline to provide signal-to-noise ratios. Using a through-transmission setup, 2-dimensional beam plots from the back wall surface were collected using a needle hydrophone. These were compared between the parent metal and through the weld volume. Results 2.25MHz probe frequency showed in general the highest signal-to-noise ratios for this experimental configuration. In the pulse-echo setup, there was a high dependence of backscattered noise on the welding position at all probe frequencies, demonstrated by a difference in noise properties between inspections from either side of the weld. In the through transmission setup, the maximum signal amplitude difference between the parent and weld metal ranged from equivalent at 1MHz to ~15dB at 10MHz. At all probe frequencies, reflection at the weld fusion face deviated the sound from its nominal path to a more acute angle. Conclusion: The work highlights the importance of correct UT parameter selection for the inspection of austenitic welds, as well as a thorough understanding of the influence of weld microstructure. The experimental methodology developed can be adapted for other material types, and the results used to validate modelling of beam propagation through anisotropic materials.