

Development of a Technique of Crack Detection against the Background of a Design Lack-of-Penetration in Welded Joints on Cylindrical Items

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Abstract. Technologies of welding some items allow the presence of a design lack-of-penetration remaining after welding. On the other hand, this is one of the most hazardous types of stress concentrators in welded joints, and, for this reason, it is a potential site for crack initiation. Fracture of a welded joint with a crack propagating from a lack-of-penetration is a question of time, during which the action of repeated-static or cyclic loads due to equipment operation, changes in the volume of the stored product, operating pressure variation, temperature gradients, traffic, wind gusts, deep-water waves will result in the crack growing up to the critical size.

Under these conditions detection of this kind of cracks against the background of an interfering signal from the design lack-of-penetration becomes a priority during NDT of such welds.

The E.O.Paton Electric Welding Institute of the NAS of Ukraine has conducted investigations and developed a technique of ultrasonic testing of welded joints on cylindrical items to detect cracks of different orientation propagating from the design lack-of penetration. The technique is based on a combination of the time and amplitude analysis of diffraction waves, arising at the tips of the crack and lack-of-penetration.

Results of mathematical simulation and research performed on samples of the actual items with simulated cracks of different size and orientation were used to establish the optimum parameters of testing (transducer frequency and angles, duration of excitation pulse, shape and size of the piezoelectric cell) and schematics of UT transducer positioning, depending on surface curvature and welded joint thickness, as well as features and requirements to ultrasonic equipment for operation with diffraction waves. Results of production trials of the developed testing technology confirmed its validity.