

Studies of Ultrasonic and Phased array inspection NDT techniques on high thick SS316L welded joint mock-ups of fusion reactor components fabrication applications

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Fusion reactor components manufacturing is mainly deals with Austenitic stainless steels with different type welding techniques and kind of weld structure joints. Thick steel like 40 mm & 60 mm plates are used mainly in the fabrication of vacuum vessel, divertor and other supporting structures with different weld joining techniques like Tungsten Inert Gas (TIG) welding, Narrow Groove TIG (NG-TIG) welding, Electron Beam Welding (EBW). The challenges arise to qualify the acceptance of welds inspection with NDT techniques. X-ray radiography examination shows limitation for thicker steels inspection and Liquid dye penetrant tests pose restriction for inside vacuum vessel welded joints due to penetrant chemicals exhibit outgassing effects. Ultrasonic and Phased Array examinations techniques have shown advantage over the conventional techniques for the welds inspection in case of thick plate steel welded structures by providing the size and shape of weld defects (Porosity, under cut, Cracks, inclusions etc) in critical positions and depth inspection in the welded joints. The present paper reports the examination studies carried out with conventional ultrasonic examinations (A-scan technique), Phased Array examination techniques on the different weld SS316L plate mock-ups. Weld mock-up coupons have been fabricated with different welding procedures (TIG, EB, and NG-TIG) and joint preparations such as butt and Narrow groove, T-weld joints of 40 mm and 60 mm thick plates of SS316L. Weld joints of T- type coupons have been fabricated with TIG welding and are examined with the conventional and Phased Array ultrasonic examinations. Calibration is implemented with known defect size and reference methodology with Phased Array ultrasonic inspection technique. The Phased array examination (PA, Angle beam phased array S-scan, 2.25 MHz probe), has shown superiority over the conventional Ultrasonic technique by revealing the minor size defects with mapped welded regions. However, the weld defects detected are well within the acceptable limits. The welded samples are inspected by X-ray radiography is compared and it is noted that the line defects and porosity conditions are not revealed. The present paper discusses the welding mock-ups tests like Calibration tests, NDT techniques methodology and results of the weld defects.

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